What address standards tell us about addresses

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Abstract

An address is most often used to direct people to a delivery point. Standardizing addresses streamlines the delivery process, whether this delivery is for postal mail, emergency response, utilities (water, electricity, sewerage, etc.), financial services, or any other kind of service. Address standards have been developed and are being developed by a number of countries and organizations. The objectives of this paper are to present a number of address standards, to share experiences and lessons learnt from developing, as well as using, these address standards, and to analyze the standards systematically in order to better understand what an address is and what the purpose and benefits of different address standards are. We believe that such an analysis will contribute towards the understanding of what an address is and what the purpose of an address standard is; and we hope that the paper will also assist relevant stakeholders in developing and using address standards.

Keywords: address standard, address, location, address data, standard, postal address, street address

1. Introduction

An address is most often used to direct people to a delivery point. The notion of directing someone or something is evident in the origin of the word 'address', which is derived from the Latin *directus*, past participle of *dirigere*, *to direct* (Dictionary.com 2004). The word 'address' as a verb with the meaning 'to direct spoken words (to someone)' is known to be in use in the English language since 1490; 'address' as a noun in the sense of 'formal speech' from 1751; and

the meaning was expanded in the seventeenth and eighteenth centuries to the notion of directing something, as a letter, 'straight' to where somebody lives, which led to the use of the noun as 'superscription of a letter' (1712) and 'place of residence' (1888) (Douglas Harper 2001).

Postal history tells us that postal systems for transporting written documents have been around in various forms and in various parts of the world since the earliest days of writing (Twitchett and Mote 1998, Dorn and MacClellan 2006). In these early postal systems, letters were hand delivered from source to destination. In Europe, street addresses were first assigned in the eighteenth century when cities started to expand and a need arose to identify individual buildings (Voelckel 2002). The purpose of postal delivery is reflected in the definitions for an address found in many English dictionaries, of which some are shown in Table 8 of section 3.

However, an address can be considered in the broader sense of being the description of a location, not only for postal delivery, but for all kinds of service delivery, ranging from 'physical' services such as utility services, billing, goods delivery, and emergency dispatch; to more 'abstract' services such as opening financial accounts, credit applications, tax collection, and land and property registration (Coetzee and Cooper 2007b, Walker 2008). There have been a number of unsuccessful attempts over the years to develop a universal addressing system based on geographical coordinates (latitude and longitude), but while computers might 'prefer' addresses expressed as coordinates, for human use an address should be in the form of human-understandable geographic identifiers, i.e. intelligible names and context (Coetzee and Cooper 2007b, Weilenmann and Leuchovius 2004).

Standardizing addresses streamlines the service delivery process. Barr (2007), Coetzee and Cooper (2007a), Lind (2007), Nicholson (2007) and Coetzee *et al.* (2008b) describe the benefits of standardized addresses to the economy, society and governance, while Farvacque-Vitkovic *et al.* (2005) explore the links between street addressing and civic identity along with support for various services and economic development.

Address standards have been developed and are being developed by a number of countries and organizations, including Australia and New Zealand (AS/NZS 4819:2003), Denmark (OIOXML Adresseguide 2006), Europe (EN 14142:2003), France (AFNOR XPZ 10-011), New Zealand (New Zealand Post 2006), the Organization for the Advancement of Structured Information Standards (OASIS CIQ 2007), South Africa (SANS 1883), the United Kingdom (BS 7666:2006), the United States of America (Draft Street Address Standard and USPS Publication 28 2008), and the Universal Postal Union (UPU S42:2006). Previously, ISO/TC 154, *Documents and data elements in administration, commerce and industry*, in collaboration with the UPU, had developed ISO 11180:1993, *Postal addressing*, but this standard was only for the dimensions and location of the postal address on forms, and was withdrawn in 2003. Coetzee *et al.* (2008b) analyzed a number of national and international address standards and found that most of the analyzed standards include geo-referencing by coordinates; describe all kinds of addresses; a data model, commonly described in the Unified Modeling Language (UML), while XML or XML languages are popular as encoding formats. The analysis did not include the specific needs of postal address standards, which focus on

postal addresses that deal with names and describe how postal addresses should be formatted from parts (i.e. focus on rendition). Non-postal address standards usually do not provide specifications sufficient for these postal needs.

Location and address-related standards have been developed by ISO/TC211, *Geographic information/Geomatics*, such as ISO 19111:2007, *Geographic information – Spatial referencing by coordinates*, which describes the structured metadata required for using coordinates; ISO 19112:2003, *Geographic information – Spatial referencing by geographic identifiers*, which describes how to link something to a location through the identifier(s) (name) of a geographic feature; ISO 19133:2005, *Geographic information – Location based services – Tracking and navigation*, which includes a tentative address model to describe locations for tracking and navigation; and ISO 19148, *Geographic information – Location based services – Linear referencing*, currently in development, for data and services in support of linear referencing.

In 2008, ISO/TC 211 arranged an address standard workshop, hosted and sponsored by the Danish National Survey and Cadastre: *Considering the issues related to an international address standard* (Coetzee et al. 2008a). Subsequently, ISO 19160, *Addressing*, a stage zero project for preliminary work on address standardization was proposed and approved, and a first project meeting was held in November 2009 in Quebec, Canada. The project has two objectives: 1) Investigate and formulate requirements in relation to addressing; 2) Make recommendations on whether standards should be developed and if so, how this should be done. The project's justification points out that addresses lie between geographic information, electronic business and postal systems, amongst others, and therefore quite a few stakeholders are involved. Most of these either participate in or are aware of ISO 19160.

In the preparatory work of the European programme for a spatial data infrastructure (SDI), INSPIRE (**IN**frastructure for **SP**atial **I**nfo**R**mation in **E**urope), the concept of 'reference data' has been defined as a category of datasets that plays a special role. According to the INSPIRE definition (Rase et al. 2002), reference data must 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. Addresses fulfill these requirements and are therefore listed as a priority spatial reference dataset in Annex 1 of the INSPIRE Directive (2007). A number of INSPIRE implementing rules are being developed to ensure that these datasets are interoperable and seamlessly accessible across all of Europe. The 'INSPIRE Thematic Working Group (TWG) on Addresses' was tasked in 2008 with improving the interoperability and harmonization of address data in Europe through the creation of a neutral data specification for addresses (Coote 2008). As a result a draft data specification on addresses was published in September 2009 (INSPIRE Thematic Working Group Addresses 2009). In the INSPIRE Implementing Rules on interoperability of the spatial datasets and services, expected to be published in mid 2010, the requirements for address data will be based on this draft data specification.

A current initiative by the UPU, 'Addressing the world – An address for everyone' (see http://www.upu.int/en/activities/addressing/addressing-the-world-initiative.html) has led to the establishment of a formal inter-organization addressing working group (IOAWG). Its aim

is to create synergies between UN organizations, intergovernmental organizations and any other interested parties, such as academia, non-profit organizations, development banks or businesses, in order to better understand the addressing issues, define a common action plan, and implement it. The ultimate goal of the initiative and its campaign is to provide everyone with an address. The main goals of the IOAWG are as follows:

- to share information on addressing issues and projects related to addressing at all levels;
- to elaborate the objectives, method and outcomes of the work to be done by the group and by different parties involved in concrete projects; and
- to coordinate the implementation of the global approach of the "Addressing the world – An address for everyone" initiative.

Due to their service, infrastructure and land administration responsibilities, it is common that a local authority establishes and maintains address data for its area of jurisdiction (Levoleger and Corbin 2005, Williamson *et al.* 2005, Coetzee *et al.* 2008b). A European survey on addresses and address data gives clear evidence that address systems, along with address master files or address registers, exist in many European countries. Some of these are collated from individual local authorities, others are produced on a national scale and in some countries address data is maintained at local authorities and not (yet) collated into a national dataset (Levoleger and Corbin 2005). National datasets and local datasets face different challenges: while large national datasets must contend with a diversity of address formats, local datasets require better positional accuracy (Zandbergen 2008). According to the European survey, only very few published standards for address data exist, making the task of 'interoperable and seamlessly accessible' address datasets 'across all of Europe', as specified in the INSPIRE directive, even more difficult. More recent research by the European Address infrastructure project (EURADIN), part-funded by the European Commission, has confirmed these findings (see https://www.euradin.eu) and thus, this paper is of relevance now.

The objectives of the paper are 1) to present a number of address standards and share experiences and lessons learnt from developing, as well as using, these address standards; 2) to analyze the standards in order to better understand what an address is and what the purpose and benefits of different address standards are. We believe that such an analysis will contribute towards the general understanding of addresses and that the paper will be a source of information for developers and users of address standards.

2. Standards

In this section we present address standards from Denmark, the Organization for the Advancement of Structured Information Standards (OASIS), South Africa, United Kingdom, United States and the Universal Postal Union (UPU). For each standard an overview table is included, along with a short description of the content of the standard.

2.1 Denmark

In Denmark the formal regulation and standardization of street names and addresses started with the introduction of a Central Population Register (CPR) in 1968 and the Building

and Dwelling Register (BDR) in 1977 (Lind 2008). Key drivers were government's requirement for enhanced and reliable registration of citizens' residential addresses for tax purposes, social welfare and statistics. Since then, this de facto address standard has been enforced and is used in a large number of public registers (e.g. the Central Business Register, CBR), in utility services, and also in the first generation of digital large-scale topographic maps.

In 2001, all public regulation on addresses was transferred into the 'Act on Building and Dwelling Registration'. The act pointed out the municipalities' responsibility to assign all road names and addresses and to maintain the public reference register for addresses. Detailed regulation of the elements in the address system, e.g. object types, attributes, value domain etc., is provided in the Statutory order on Road Names and Addresses (DECA 2006). It is thus characteristic that the Danish address system is based on legislation.

Development of public IT standards for address data was started in 2003 by the initiative of the Joint Danish e-Government committee. As a result of the process, all components of Danish addresses were defined, XML-tagged and included in the e-Gov data repository as 'core components' together with two guideline-documents: 'Addressguide' (2006) and 'Guideline for Address Point' (2007). It has not yet been decided if theses standards should be developed into a formal Danish Standard (DS), according to CEN or ISO requirements.

As a small and relatively homogenous country, the Danish address system is based on seven mandatory and two optional elements, illustrated in Fig. 1. Two address types are defined:

- *Definitive access address* identifies a way of access on the ground level to a building (e.g. through a main entrance door), a technical construction or to a plot of land (e.g. land parcel)
- *Unit address* identifies a door, which gives access to a dwelling or business entity inside a building (e.g. the entrance door to a flat, shop or office inside the building). If the main entrance door only gives access to one dwelling or business unit like in a one-family house, the access and unit address are overlapping).

Table 1
Danish address standard

Standards generating body	XML-committee (Joint e-Gov data standards committee)
Technical committee	OIOXML Core Component Working Group
Number	(none)
Name	OIOXML Adresseguide (en: Address Guideline) OIOXML Dokumentationsguide for Adressepunkt (en: Guideline for Address Point)
Structure	Two online documents
Status	Published as public data standards for e-Government (not formal DS-standards by Danish standards body, 'Dansk Standard'
First started	2003

Published	2006, 2007
Distribution	Online: http://www.adresse-info.dk/Portals/2/Dok/Dokumentationsguide_for_adresse_2006-02-13.pdf http://www.adresse-info.dk/Portals/2/Dok/OIOXML_Dokumentationsguide_for_Adressepunkt.pdf
Supporting material	The data standards are enforced by the 'Law of Building and Dwelling Registration' and the 'Statutory Order on Road Names and Addresses' which regulates the authority, guidelines and process of addressing and of address data management
Purpose	To describe the address data elements and complex types including spatial properties in order to enable data exchange.

As a result of an agreement in 2003 between government and the organization of municipalities, address data from the public reference address register is provided free of charge for public as well as commercial use. As a result, today almost all providers of yellow pages, mobile location-based services, car navigation systems, as well as e-government applications, emergency services, utilities and postal services, use the same publicly available address data as a common reference.

A number of Danish business case analyses (Lind 2007) have shown that addresses add value to society and are an important element of a modern society's infrastructure. The overall benefits of providing access to address data based on a common, published standard are significant.

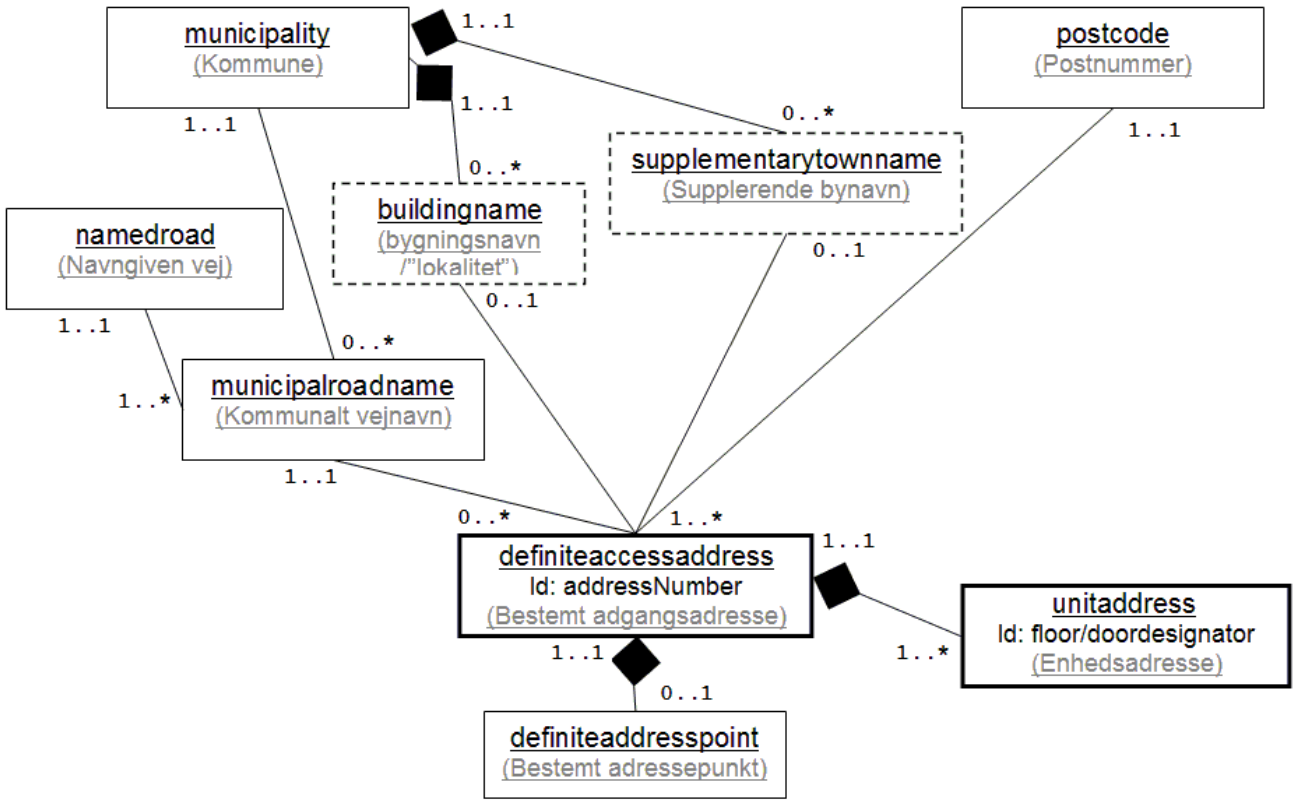

Fig. 1. Elements of the Danish address system

2.2 Organization for the Advancement of Structured Information Standards (OASIS)

OASIS Customer Information Quality (CIQ) technical committee (TC) publishes a set of XML specifications for defining, representing, interoperating and managing 'PARTY (person or organization) CENTRIC INFORMATION' that are open, vendor neutral, industry and application independent, and are able to represent different international formats of party names and addresses.

Around 2000, when e-commerce and e-business started to have a significant impact on industry, industry standards were introduced. 'Party' data is key to any global e-commerce transaction and at the time, specifications to represent and exchange 'party-centric data' in a standard and consistent manner did not exist. Hence, CIQ TC was formed to address this complex challenge. To date, this is the only committee in the world that is dedicated to developing Party Information Specifications that are vendor, application, industry and technology neutral, as well as open and global.

The CIQ family of specifications represents party data (e.g. name and address) independent of any culture, geographical location, application or industry at an abstract level (simple representation of data in free text format) or at a detailed level (complex representation, i.e. breaking the data into its atomic elements, in structured format).

Table 2
OASIS International Address Specification

Standards generating body	Organization for the Advancement of Structured Information Standards (OASIS)
Technical committee	Customer Information Quality
Number	n/a
Name	Name (xNL), Address (xAL), Name and Address (xNAL), Party (xPIL) and Party Relationships (xPRL)
Structure	Two documents, one for xNL, xAL and xPIL, and the other for xPRL
Status	Version 3.0 Committee Specifications (final)
First started	2000
Published	July 2001 (Ver 1.0), July 2002 (Ver. 2.0), November 2008 (Ver 3.0)
Distribution	The standard and supporting material are available online at http://www.oasis-open.org/committees/ciq
Supporting material	Supporting documentation includes Frequently Asked Questions (FAQ), General Introduction and Overview of the specifications, Specifications Package Overview, Release Notes, Installation Notes, Specifications Technical Overview, and Presentation material on how to customize the specification to meet specific business requirements, plenty of examples and UML logical models and XML schemas with supporting HTML documentation
Purpose	To deliver royalty free, open, international, industry and application neutral XML specifications for representing, interoperating, and managing Party (Person/Organization) Centric Information (Name, Address, Party Profile and Party Relationships)

Fig. 2 shows some key uses of party centric data in industry and application domains, which the CIQ specifications support.

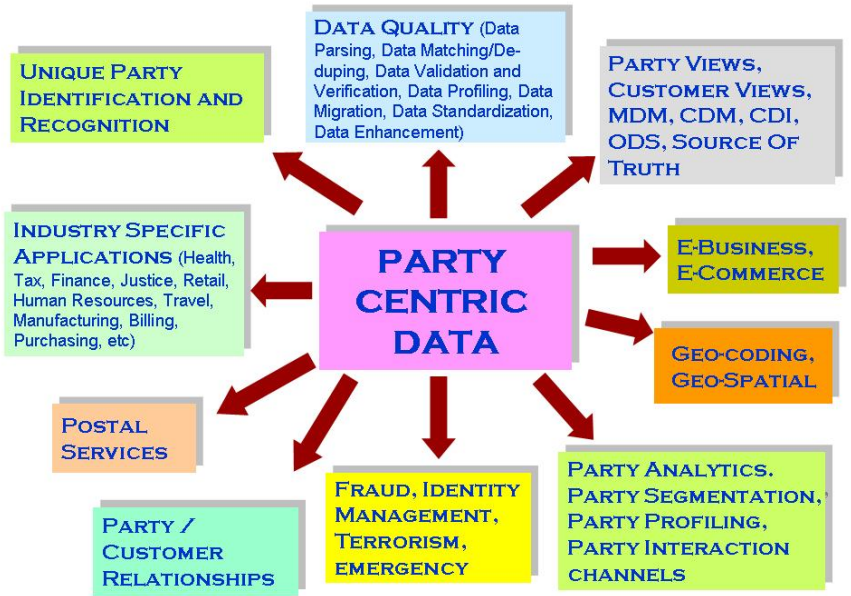

Fig. 2. Party centric data

Name and address information is the most complex of all party data. It is volatile because names and addresses change often. The data is often cluttered when recorded. For example, a single address can be represented in many ways. Addresses vary from country to country because they are closely associated with the geographical location, culture, race, religion and language. There are 130+ address formats and 36+ name formats in 240+ countries and territories.

It is not a trivial task to represent addresses from multiple countries in a structured manner, while at the same time preserving the address semantics, in a single data model (XML Schema) that is simple to implement. Address structure and its semantics vary from country to country. XML tags provide metadata, but do not define the semantics of the data. CIQ specifications give users control to define the semantics of the data without changing the data model, at the same time ensuring that user customization does not break conformance to the specification. OASIS CIQ TC has not yet come across an address that cannot be represented in its address data model. For this reason Google Earth/Maps implement the CIQ data model for addresses in a structured format.

Addresses supported by xAL include airports, business/commercial parks, caravan parks, community developments, dual (primary and secondary), educational institutions, entertainment/recreation parks, hospitals, large mail users (e.g. hospitals, industrial zones), marinas, military, ports, postal delivery points (e.g. P.O. Box, Mailbag, Mail Stop, Pigeon Holes), retirement villages, resorts, royal highness, rural (with land, air and water access), sporting venues, territories, tribal, simple urban, complex urban, utility urban, ranged urban villages, canals, banks, vacant lands (e.g. lot), location type reference addresses, and landmark based reference addresses.

CIQ specifications are free of intellectual property rights, licenses, patents or royalties and are free for the public to download and use (no registration required). The specifications are developed in a 'true open process' environment advocated by OASIS, i.e. specifications are not developed behind closed doors and therefore, the public can review and view all activities of the CIQ TC on the CIQ TC web site.

2.3 South Africa

In 2004 the South African Bureau of Standards (SABS) initiated the project to develop a South African National Standard (SANS) for 'a standard framework for South African addresses'. The aim of the standard is not to devise a new system of addressing or to build a national address database, but rather to enable interoperability in address datasets, which will facilitate developing a national address database. The standard, SANS 1883, consists of three parts:

- SANS 1883-1, *Geographic information – Address, Part 1: Data format of addresses*
- SANS 1883-2, *Geographic information – Address, Part 2: Guidelines for addresses in data bases, data transfer, exchange and interoperability*
- SANS 1883-3, *Geographic information – Address, Part 3: Guidelines for address allocation and updates*

```
StreetAddress = StreetIdentifier, Locality

StreetIdentifier = [CompleteAddressNumber | StreetNumberRange],
                   CompleteStreetName

CompleteStreetName =
  StreetNameAndType, [[StreetNameDirectional], StreetNameModifier]
| SubStreetNameAndType, [[StreetNameModifier], StreetNameDirectional]
| [StreetNameModifier], SubStreetNameAndType, [StreetNameDirectional]
| [StreetNameDirectional], SubStreetNameAndType, [StreetNameModifier]

Locality = PlaceName, [Town], [Municipality], [Province],
[SAPOPostcode], [Country] | [CountryCode]
```

Fig. 3. The SANS 1883 Street Address Type

SANS 1883-1 and SANS 1883-3 were published in 2009, while SANS 1883-2 has been put on hold in anticipation of the results from a workgroup on XML standards in government. SANS 1883-1 defines twelve address types that describe all forms of addresses currently in use in South Africa: the Street address, Site address, Intersection address, Building address, Farm address, Informal address, Landmark address, SAPO box address, SAPO street address, SAPO site address, SAPO post restante address, and SAPO-type village address.

Table 3
SANS 1883, South African address standard

Standards generating body	South African Bureau of Standards (SABS)
Technical committee	SC71E – Geographic Information, the local mirror committee of ISO/TC211 – Geographic information/Geomatics
Number	SANS 1883
Name	Geographic Information - Address
Structure	SANS 1883-1: Data format of addresses SANS 1883-2: Guidelines for addresses in databases, data transfer, exchange and interoperability SANS 1883-3: Guidelines for address allocation and updates
Status	SANS 1883-1 and SANS 1883-3 are committee drafts
First started	2006
Published	2009
Distribution	SABS, Private Bag X191, Pretoria, 0001, South Africa Tel.+27 12 428-6883, Fax. +27 12 428-6928, www.sabs.co.za
Supporting material	Parts 2 and 3 provide guidelines respectively for address data in databases and the assignment of addresses. A website with overview information, sample data and presentations is available at www.cs.up.ac.za/~scoetzee/sans1883.
Purpose	To describe the data elements of different address types in order to enable address data exchange.

An address type comprises various data elements, such as the street number, street name,

building information, and the locality reference. The Extended Backus Naur Form (EBNF) for the street address type is shown in Figure 1. While SANS 1883-1 describes address types currently in use, SANS 1883-3 recommends that only addresses of the *Street address* type in formal areas and the *SAPO-type village address* type in informal areas should be newly allocated.

SANS 1883-1 provides metadata, amongst others, for the originator and distributors of the address data, the point of observation (e.g. center of the property or street front), the life cycle stage (future, active, retired) and the official status of the address.

In contrast to postal mail, which is usually delivered by a single agency or institution within a country that can prescribe the format and content of an address on the postal item, the SANS 1883 definition for an address includes service delivery by any institution in any number of ways (by post, by hand, by vehicle, or even virtually as a financial service), resulting in ambiguous addresses. For example, the *Street address* type and the *SAPO street address* type differ only in the locality part of the address (suburb vs. post office, respectively). Table 4 lists two addresses that refer to the same service delivery point even though their localities seemingly differ.

Table 4
SANS 1883 sample addresses

Street address type	546 Puccini Street, Constantia Park
SAPO street address type	546 Puccini Street, Glenstantia, 0181

2.4 United Kingdom

Historically in the UK a notional standard for addresses based on the needs of the postal delivery service had been used wherever address data was held. In the early 1990's, recognizing the limitations of this approach in both technical and practical terms when applied to the wider geographic non-postal world, local government started working towards a national property gazetteer and the creation of a formal British Standard for both properties and addresses. This standard has subsequently been reviewed and its relevance and applicability confirmed in 2000 and 2005 with the latest review bringing BS7666, *Spatial datasets for geographic referencing*, in line with ISO 19112, *Geographic information, Spatial referencing by geographic identifiers*.

The evolution of the previous postal based lists and the development of the formal UK property and address standard and the subsequent gazetteer implementation need to be viewed against:

- a confused legislative framework dating back to 1847;
- 408 local authority bodies in England, Wales and Scotland with statutory obligations in relation to planning and development control and street naming and numbering;
- 172 highway authorities with road creation and maintenance duties;
- State owned postal, surveying, land registry, census and taxation services all creating address lists based on their own operational requirements.

The specific implementation of the BS7666 standard within local government requires each local authority to create and maintain a local gazetteer of all land and property within their administrative area and to record address information for these properties in a standard format. Data entry conventions, contractual relationships and timetables have been agreed to ensure that gazetteers maintained to a common standard are made available. These standardized gazetteers have been combined into a national dataset that has grown in quality and sophistication since 2001.

The National Land and Property Gazetteer (NLPG) covers all of England and Wales and comprises 29 million property records with over 32 million associated addresses. Underlying this project is a definitive street gazetteer containing details of 1.5 million records.

Table 5
BS 7666, Spatial datasets for geographical referencing

Standards generating body	British Standards Institution
Technical committee	IST/36
Number	BS7666:2006
Name	Spatial datasets for geographical referencing
Structure	BS7666-0:2006 Part 0: General model for gazetteers and spatial referencing BS7666-1:2006 Part 1: Specification for a street gazetteer BS7666-2:2006 Part 2: Specification for a land and property gazetteer BS7666-2:2006 Part 5: Specification for a delivery point gazetteer
Status	Adopted by local government in England, Wales and Scotland as basis for national gazetteers
First started	1995
Published	1995, 2000 and 2006
Distribution	Copies of the standard can be ordered from BSI customer services or from www.bsi-global.com
Supporting material	Conventions and guidelines produced by local government and available from www.nlpg.org.uk
Purpose	To provide a common structure for gazetteers of any class of geographic object

Grid coordinates are held against each property record along with detailed classification information and full metadata relating to its lifecycle. To reflect the rich history that is addresses in the UK, each property can optionally have more than one address label attached to it. The key to usage of the NLPG is the nationally unique UPRN (Unique Property Reference Number) allocated to each property at the time of its creation.

A national gazetteer for Scotland has also been developed in accordance with BS7666 and a similar project in Northern Ireland is approaching maturity.

Local Government in the UK participated in the INSPIRE project and the NLPG addresses will shortly be available in an INSPIRE compliant format.

The benefits of the standards based approach in terms of efficiency; revenue protection and

better service provision have been increasingly recognized and realized at both local and national levels. Web based one-stop shops offering the citizen access to information on all of the services provided by local government are the norm rather than the exception and the NLPG is now underpinning the creation of regional fire control centers and a centralized register of electors as well as forming a vital part of the next national census.

2.5 United States

The US draft standard for street, landmark and postal addresses (refer to Table 6) includes four parts:

1. Data Content defines the data elements that may comprise or describe addresses.
2. Data Classification defines classes of addresses
3. Data Quality specifies tests and measures of address data quality.
4. Data Exchange provides a complete XML schema for address data exchange.

Table 6
United States Street, Landmark, and Postal Address Data Standard

Standards generating body	US Federal Geographic Data Committee
Technical committee	Address Standard Working Group (working under sponsorship of the US Federal Geographic Data Committee)
Number	Not yet assigned
Name	United States Thoroughfare, Landmark, and Postal Address Data Standard
Structure	Part 0: Introduction; Part 1: Address Data Content; Part 2: Address Data Classification; Part 3: Address Data Quality; Part 4: Address Data Exchange
Status	Draft: submitted to the FGDC for review.
First started	1996
Published	No
Distribution	To be determined
Supporting material	None yet. An implementation guide is envisioned for the future.
Purpose	To provide a comprehensive address data standard serving the full range of address user needs: postal delivery and census enumeration, local government administration and intergovernmental cooperation, emergency dispatch, the creation and administration of master address repositories by local address authorities, and the aggregation of local records into larger regional, state, and national address databases.

Address Definition. The standard proposes a new definition of 'address' that distinguishes addressing from the two other types of spatial referencing systems: coordinate reference systems and linear reference systems. The definition differentiates the three broad groups of address classes: thoroughfare addresses, landmark addresses, and postal delivery point addresses.

Address Classes. The standard classifies addresses according to their syntax, that is, their address elements and the order in which the elements are arranged. The standard classifies all US addresses into a simple, complete taxonomy of ten US address patterns:

Thoroughfare Address Classes

1. Numbered Thoroughfare Address ('123 Main Street')
2. Intersection Address ('Fifth Avenue and Main Street')
3. Two-Number Address Range ('405-411 West Green Street')
4. Four-Number Address Range ('900-962, 901-963 Milton Street')
5. Unnumbered Thoroughfare Address ('Forest Service Road 698')

Landmark Address Classes

6. Landmark Address ('Statue of Liberty')
7. Community Address ('123 Urbanizacion Los Olmos')

Postal Delivery Address Classes

8. USPS Postal Delivery Box ('PO Box 16953')
9. USPS Postal Delivery Route ('RR 1, Box 100')
10. USPS General Delivery Office ('General Delivery')

A catch-all 'General Address Class' handles files that mix addresses from various classes, and addresses whose class has not been determined.

Address Elements. The standard names and defines the simple and complex data elements needed to construct addresses, covering address numbers and their components; street names and their components; subaddresses (apartments, offices, suites, etc.) and their components; landmark names; larger areas (place name, state, ZIP code, country); USPS postal address elements (PO Boxes, rural routes, etc); and USPS address lines (Delivery Line and Last Line).

Address Attributes. The standard defines attributes needed for address documentation, mapping, and quality control. Collectively the attributes constitute record-level metadata for each address. Key attributes include the AddressID, coordinate location, lifecycle status (potential, proposed, active, retired), class (in terms of the taxonomy described above), feature type (e.g., parcel, building, infrastructure component, etc.), official status (official, alias, unofficial, etc.), address authority, dataset, date created/retired.

Address Reference System: The Local Framework for Address Assignment. The standard introduces the idea of an address reference system – the framework of local rules, both spatial and non-spatial, by which addresses are assigned and validated within a specific area – which, in turn, is important to data quality testing.

Data Quality. The standard specifies a complete suite of address data quality tests, including full procedural specifications and SQL pseudo code test scripts.

Data Exchange. The standard includes an XSD that integrates the XML element, attribute, and class models into a single XML schema, providing XML templates for

monolithic and transactional data exchanges.

2.6 Universal Postal Union

History. UPU address standardization began in 2001 with a proposal to create standards defining postal address elements, procedures facilitating production of final presentation and the electronic exchange of name and address data.

UPU standard S42 is based on CEN TC 331 work on postal address components and was approved in 2002. In 2006, S42 was divided into a generic Part A and a country-specific Part B to facilitate the process of adoption by CEN. Work on the exchange format began in 2006 and resulted in standard S53 being approved for status 0 in February 2009.

Content. Table 7 provides an overview of the UPU postal address standards.

Table 7
UPU postal address standards

Standards generating body	Universal Postal Union (UPU)
Technical committee	UPU Addressing Group
Number	UPU S42a, S42b and S53
Names	S42: International postal address components and templates S53: Exchange of name and address data
Structure	S42a: elements and template languages (NLT[a] for humans and PATDL[b] for computers) S42b: country-specific templates S53: electronic exchange format
Status	S42a: Part of draft standard in Version 6 S42b: Part of draft standard in Version 6 (Templates for 16 countries, 8 in development) S53: Working draft in Version 1
First started	2001
Published	S42 in 2006, S53 in 2009
Distribution	UPU International Bureau. Standards Programme, 3000 Berne 15, Switzerland (tel: +42 31 350 3111, fax: +42 31 350 3110, e-mail: standards@upu.int)
Supporting material	Overview of the standard at: http://xml.coverpages.org/ni2003-06-17-a.html PATDL[b] user guide
Purpose	Provide for postal addresses: elements, template languages, country-specific templates and format of electronic transport to facilitate their formatting, validation and exchange

[a] NLT: Natural language notation [b] PATDL: Postal address template description language

S42a comprises a dictionary of postal address components and the definition of human- and machine-readable address template languages for expressing formal descriptions of address formats. The structure of these components is illustrated in Fig. 4. S42b contains country templates expressed in languages defined in S42a. S53 contains the XML Schema for exchange of name and address data, supporting not only S42 elements and templates, but also

composites, addresses split by line and entire address blocks.

UPU focuses on the address used on postal mail items. It is understood as a set of information, including not only data for specifying the delivery point, but also mail dispatch information, such as mail stop and party name (organization or individual) that can be used to describe addressee and/or mailee roles. These two additional pieces of information go beyond the scope of the address, which is understood to be just a delivery point.

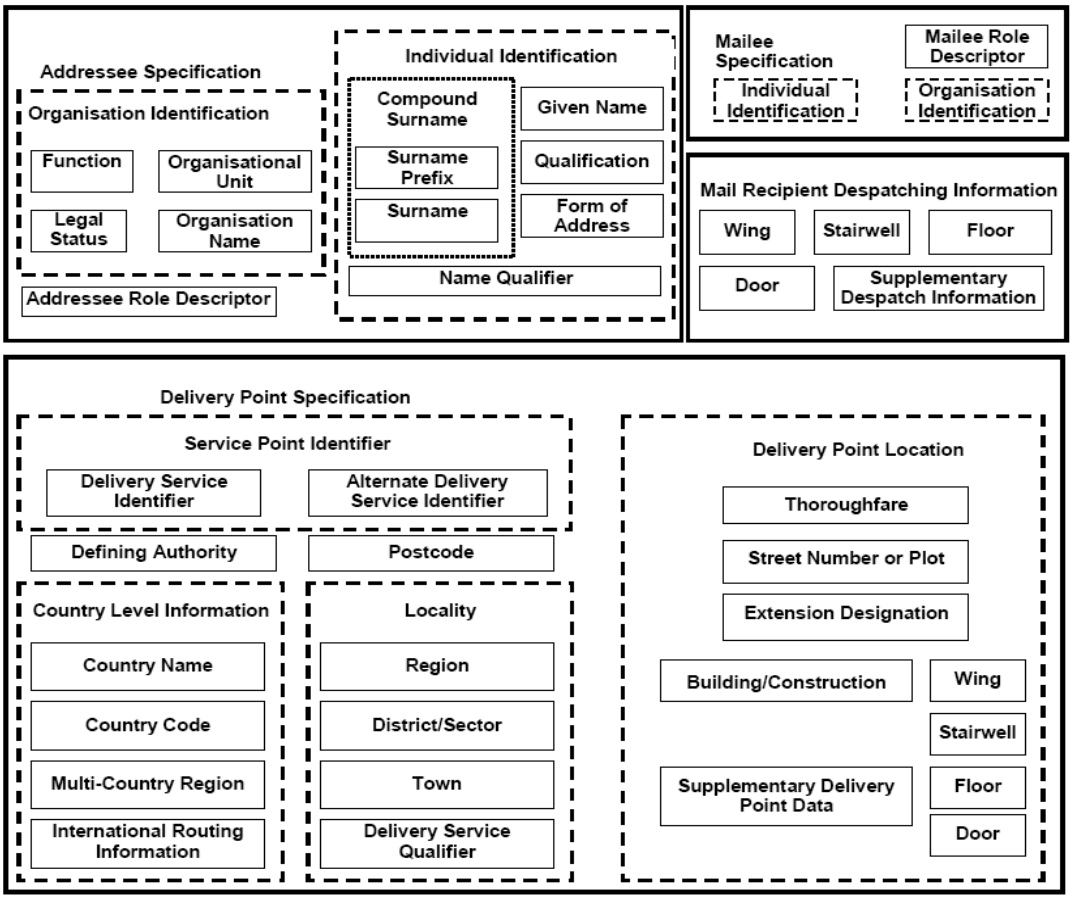

Fig. 4. The structure of S42 components

Postal addresses exist mainly in two forms: rendered on address labels and un-rendered (listed in contacts' data sets). The requirement shared by both forms is completeness, i.e. the quality of containing all data elements needed. Furthermore, the address in the rendered form should be correctly formatted; in the un-rendered form, it should comprise well-defined elements. Transformations between these two forms are carried out via the processes of rendition and parsing. S42 supports the rendered form by providing elements, and the un-rendered form by describing the rendition process (i.e. templates).

Purpose. The long-term objective of UPU postal address standards and other addressing projects is to eliminate postal items with invalid addresses from the postal network. The dictionary of components is expected to facilitate the formal description of actual address representations and the definition of procedures for mapping between them. The S42b

templates can be used to automate the formatting of addresses from databases and, in conjunction with delivery point reference data sets, provide a basis for address validation.

S42b forms part of an implementation program, with a prescriptive approach that promotes postal address standardization at national level. Templates are being developed in cooperation with member countries and describe recommended formats. While the aim of S42a is stability, S42b will be regularly extended until templates have been developed for all UPU member countries. S42-6 provides templates for 16 countries; 10 more are now being developed.

3. Discussion and analysis

Table 8 lists definitions for an address from a variety of sources. The dictionary definitions explain an address in the context of sending or directing a piece of mail to a recipient (a person or an organization), while some definitions from standards do not refer to postal delivery at all. In the context of information technology, the meaning of the word address has evolved to being a label, as an integer, symbol, or other set of characters, designating a location, register, etc., where information is stored in computer memory (Dictionary.com 2008). Thus, this is a virtual address rather than a physical address.

Some address definitions say something about how the location is described, e.g. 'the house and name of the road' (Cambridge Advanced Learner's Dictionary); 'in relation to the road network' (Lind 2008); and 'by reference to a thoroughfare' (US draft address standard). Some definitions also describe what one would find at the location, e.g. 'where a person lives or works' (Cambridge Advanced Learner's Dictionary); 'a property, building, technical facility or the like' (Lind 2008); 'an object' (BS 7666:2006); 'service delivery point' (SANS 1883:2009); and mail or postal 'delivery point' (OASIS CIQ V3.0 and UPU S42:2006).

Table 9 shows a comparative analysis of the occurrence of certain words in the address definitions from the standards presented in section 2. Reference to a road or thoroughfare is included in two; 'postal' or 'mail' is included in three; and 'addressee' in only one definition. If any group of people taken at random were asked to define the word 'address', they would probably come up with as many definitions as there were people in the group. For most people, the word 'address' signifies a means of identifying a location that allows goods and messages to be delivered to it (Vivas and Lubenow 2009). If one assumes that language experts, as opposed to address experts, compile dictionaries, the dictionary definitions should reflect the general knowledge interpretation of what an address is. However, Some of the definitions in Table 9 deviate considerably from the context of sending or directing a piece of mail to a recipient, which is in contrast with the dictionary definitions.

It seems as if all addresses have something in common, but what? The fact that an address describes a location is not common: a Poste Restante or PO Box address, for example, does not describe a location. Neither is the delivery point at an address a common feature: the BS 7666 address definition states that there is 'an object' at the address, not a delivery point. This reminds one of the classic chicken-and-egg question: who was first, the address or the object? Is an address an object in itself, or is it a reference to which some other object, such as a person or a building, is linked? Or does an object, such as a person or a building, have

attributes to describe it, one of which is the address? A 'potential delivery point' (UPU S42:2006 definition), for example, would be a reference to which a recipient can be linked in future, while a landmark address in the US and SA address standards preempts that there is an object (a landmark) at the address.

Table 8
Address definitions

Source	Source	Definition
Cambridge Advanced Learner's Dictionary	Dictionary	the number of the house and name of the road and town where a person lives or works and where letters can be sent (Cambridge University Press 2007)
Dictionary.com	Dictionary	a direction as to the intended recipient, written on or attached to a piece of mail (Dictionary.com 2008)
Dictionary.com	Dictionary	the place or the name of the place where a person, organization, or the like is located or may be reached (Dictionray.com 2008)
Oxford English Dictionary	Dictionary	the direction or superscription of a letter, etc.; the name of the person and place to which it is addressed or directed; the name of the place to which any one's letters are directed (Oxford University Press 2007)
Wiktionary	Dictionary	direction or superscription of a letter, or the name, title, and place of residence of the person addressed (www.wiktionary.org)
Wikipedia	Encyclopedia	a code and abstract concept expressing a location on the Earth's surface (www.wikipedia.org)
Cooper (2008)	Paper	a structured, unique, complete, common reference for actual or potential service delivery to a location
Lind (2008)	Paper	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
Walker (2008)	Paper	a label used to reference a geographical object such as a property, for the purpose of identification and location, through the use of identifiable real-world objects
AS/NZS 4819:2003	Standard	the conventional means of describing, labeling or identifying an address site; and an address site is an object, place or property
BS 7666:2006	Standard	means of referencing an object for the purposes of unique identification and location
OIOXML Adresseguide (Denmark)	Standard	a structured, textual description assigned as a common reference to a definite way of access to a building, a construction or developed or undeveloped plot of land
ISO 11180:1993	Standard	set of precise and complete information on the basis of which an item can be forwarded and delivered to the addressee without searching and without there being any doubt (withdrawn)
OASIS CIQ V3.0 (2008)	Standard	a physical location or a mail delivery point
SANS 1883:2009	Standard	an unambiguous specification of a point of service delivery
United States draft address standard	Standard	an address specifies a location by reference to a thoroughfare, or a landmark; or it specifies a point of postal delivery
UPU S42: 2006	Standard	set of information which, for a postal item, allows the unambiguous determination of an actual or potential delivery point, usually combined with the specification of an addressee and/or a mailee

We conclude that addresses do not have a single common feature but rather a 'family resemblance' in the Wittgenstein sense, 'a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities of detail' (Wittgenstein 1974). An *overall* similarity in many (but not all) addresses is the description of a delivery point, while a *common* similarity of detail is the reference to a place name and/or reference to the road network in many addresses.

Table 9
Comparative analysis of address definitions in address standards

	Denmark (DK) [a]	OASIS CIQ	South Africa (ZA)	United Kingdom (UK)	United States (US)	UPU
'unique' or 'unambiguous' or 'identification'	Yes	No	Yes	Yes	No	Yes
'location'	No, but implied by 'plot of land'	Yes	No	Yes	Yes	No
'delivery point' or 'access point'	Yes	Yes	Yes	No	Yes	Yes
'mail' or 'postal'	No	Yes	No	No	Yes	Yes
'road' or 'thoroughfare'	Yes	No	No	No	Yes (also 'landmark')	No
'addressee'	No	Included in companion specification for a party	No	No	No	Yes
What is at the address?	Developed or undeveloped plot of land; Property, building, technical facility or the like;	Unspecified or mail delivery point	Service delivery point	Object	Unspecified or postal delivery point	Postal delivery point or addressee

[a] For this analysis, the definition in the OIOXML Adresseguide and the modernized version presented by Lind (2008) were included.

In countries such as Denmark legislation governs the allocation and use of addresses, while in South Africa, any free format description of a service delivery point is regarded as an address. Addressing systems vary from country to country: in many Euro-centric countries reference to a road network in the address is common, while addresses in countries such as Japan and Korea comprise a hierarchy of administrative areas without reference to a thoroughfare. Addresses are used for a wide variety of purposes: postal delivery, emergency response, customer relationship management, land administration, utility planning and maintenance, etc. Sometimes a geographic overview of addresses at a large scale is required, e.g. land administration and utility planning and maintenance. For mail delivery or emergency response, finding individual delivery points in a suburb or street is priority. In a customer analysis, individual delivery points are sometimes completely discarded and only place name in the address is of relevance.

Is an international address standard a necessity and is it feasible if addresses from different

countries do not have at least a single common feature and are governed autonomously by the respective local jurisdictions, where they are used differently for a wide variety of purposes? Table 10 compares the purpose and region of applicability in the development of the standards presented in section 2. Not surprisingly, all standards have the purpose to improve interoperability of address data. The need to exchange address data internationally is evident from the two international standards that already exist, as well as the current work on the INSPIRE data specification for addresses. None of these international standards overrule autonomous local jurisdictions, but rather describe local address systems to enable address data exchange.

The proposed development of an international address standard has much in common with the current development of ISO 19152, *Geographic information — Land Administration Domain Model (LADM)*, a standard in a domain subjected to different national legislation around the world. The project arises out of the Cadastre 2014 conceptual framework of the *Fédération Internationale des Géomtres* (FIG) and the initial focus was on cadastre – the Core Cadastral Domain Model (Van Oosterom *et al.* 2006). Through extensive consultation with the land administration community, the project's scope has evolved to encompass all aspects of land administration, including social tenure. The LADM shows that both the formal and informal land administration systems are built on the same fundamental concepts. The two goals of the LADM apply to any international address standard:

- avoid reinventing the same functionality repeatedly in different environments; and
- enable communication based on the shared ontology implied by the model.

Similarly, ISO 19144-2 aims at providing a language for describing land cover systems to enable interoperability, rather than at developing an international standard to replace existing land cover systems. This is also the approach followed by UPU-S42: S42b contains country templates for addresses that are expressed in languages defined in S42a.

Table 10
Comparative analysis of the purpose and region of applicability

	Denmark (DK)	OASIS	South Africa (ZA)	United Kingdom (UK)	United States (US)	UPU
Purpose	Regulate addressing and address data management	Representation, exchanging and managing party centric information	Address data exchange	Common structure for gazetteers	Address usage, address data management, address data aggregation	Formatting, validation and exchange of name and address data
Region of applicability	National	International	National	National	National	International

Addresses are one of the most common ways of describing a location. Because of the network of similarities between addresses, there is ample room for misunderstanding. An overarching abstract address standard comprising different parts, each addressing a different set of similarities, would enhance the understanding of these similarities and improve correct address usage and data exchange. In UPU S42, for example, a well-defined set of similarities

is already addressed.

Another set of similarities to be addressed is the multitude of address-related terms and concepts. All terms are not necessarily required or used in all address systems and address standards, but should rather confirm common terminology and concepts and eliminate misunderstandings about similar terminology and concepts. The same term is not necessarily used for the same concept in different languages. For example, 'feature' does not translate well into all languages, thus 'object' is used in some languages.

A reference model to represent a common understanding of addresses would also contribute towards understanding similarities between addresses. Such a model would illustrate the similarities, and show connections to other existing standards, standard committees and/or organizations.

Currently, when ordering goods online, one can select only the country name from a dropdown. Imagine a future where one enters the delivery address according to the specifications of the local address system and before proceeding to checkout, the address content is verified in real-time to exist.

4. Conclusion

In this paper we presented a number of national and international address standards. In our analysis of these standards we concluded that addresses do not have a single common feature but rather a 'family resemblance' in the Wittgenstein sense: a complicated network of overall and common similarities of detail. An overarching abstract address standard comprising different parts, each describing a specific set of these similarities would contribute towards a better understanding of these similarities and improve correct address usage and data exchange.

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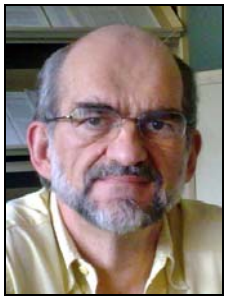
Serena Coetzee lectures in the Department of Computer Science at the University of Pretoria www.cs.up.ac.za, South Africa. She leads the Polelo research group, which focuses on spatial data infrastructures (SDIs) and distributed systems. She is project leader for ISO 19160, *Addressing* and SANS 1883, the South African address standard, and actively participates in ISO/TC 211, *Geographic Information/ Geomatics* as chair of the Programme Maintenance Group (PMG).

Antony Cooper



Antony Cooper is an Operating Unit Fellow at the CSIR in Pretoria, South Africa (www.csir.co.za). His recent activities cover crime mapping and analysis, bloodstain pattern analysis, standards, metadata, spatial data infrastructures, addresses, ethics, transport modelling and modelling armour units around harbours. His PhD research is on volunteered geographical information and spatial data infrastructures. He is Convenor of ISO/TC 211's Working Group 7 and Head of Delegation for South Africa to ISO/TC 211 Plenaries. He chairs the Commission on Geospatial Data Standards of the International Cartographic Association (ICA), and is Vice-Chair of the Geo-Information Society of South Africa (GISSA). He has an MSc and is a Registered Professional GISc Practitioner (PGP).

Piotr Piotrowski

Piotr Piotrowski works for the UPU where he is in charge of managing address reference data and information about address formats from all UPU member countries. He has also participated in the development of the UPU addressing standards, contributed to the INSPIRE TWG Addresses and recently is a member of the ISO 19160 project on addressing.

Morten Lind

Morten Lind is an Academic Architect from the The Royal Danish Academy of Fine Arts. Since 1995 he has in the National Survey and Cadastre Denmark, managed a number of collaboration projects aiming at the standardization and improvement of address data. He has been member of the INSPIRE Thematic Working Group for addresses and is currently involved in the Nordic Address Forum, the EU funded EURADIN project and the ISO/TC 211 work on addresses. His current position is in the Danish Enterprise and Construction Authority (DECA), which has the legal responsibility for addressing in Denmark.

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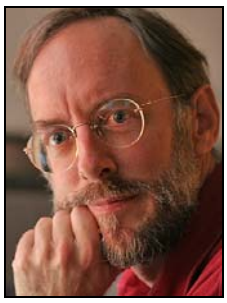
Martha McCart Wells is a co-author of the draft United States Thoroughfare, Landmark and Postal Address Data Standard. She is a principal in Spatial Focus, Inc., and has over 40 years experience in working with local governments in addressing, GIS, and planning. She is a past President of URISA International.

Ed Wells



Ed Wells is the GIS Manager for the Washington Metropolitan Area Transit Authority. He has over 25 years of public and private sector experience in GIS management in large US local government agencies. He is co-chair of the U.S. Address Standard Working Group, and Past President of the Urban and Regional Information Systems Association (URISA) Board of Directors.

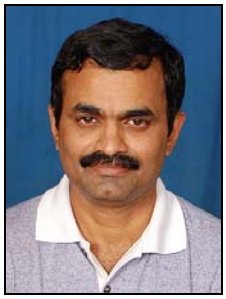
Nick Griffiths

Nick Griffiths BSc, is the Special Projects Director, Intelligent Addressing Ltd. He is a leading authority on data analysis and structure relating to addresses. He played a key part in developing the national addressing hub for Local Government in England and Wales, the National Land & Property Gazetteer (NLPG) and the National Street Gazetteer (NSG) and has worked on many other national projects including for the Emergency Services, Office of National Statistics and the Electoral Roll. Nick has been a member of the review panels for BS7666 in both 2000 and 2005 and the Addressing Technical Working Group for the European INSPIRE project and continues as a member of the NLPG technical working group.

Michael Nicholson

Michael Nicholson BSc(Hons) FRICS, is a Chartered Surveyor and Managing Director of Intelligent Addressing Ltd. He has worked in the information industry for thirty years, most of them as CEO of businesses with expertise in location information and specifically, address data cleaning, matching, analysis and collating. His company manages the national addressing hub for Local Government in England and Wales, the National Land & Property Gazetteer (NLPG) and the National Street Gazetteer (NSG). NLPG and NSG won European Best Practice awards at the eSDI-NET Awards in Turin November 2009. Michael is a member of the UK's Ministerial Advisory Panel on Public Sector Information (APPSI), a founder member of the Association for Geographic Information (AGI), and is deputy Chair of the PSI Alliance, a European body encouraging the re-use of Public Sector Information.

Ram Kumar



Ram Kumar is the Chair of the OASIS Technical Committee on Customer Information Quality that develops open, vendor and application neutral international standards for Party Data Management covering Party Name, Party Address, Other Party Information and Party Relationships. This committee was formed as the fourth technical committee of OASIS in 2000. Ram has been working in the area of party data management since 1997. Ram has over 120 publications covering various areas of Information Technology. Ram lives in Sydney, Australia.

Joe Lubenow

Joe Lubenow has been involved in addressing standardization efforts for over a decade for the UPU (S42 and S53), CEN, OASIS and IDEAlliance. He co-edited the UPU's Addressing and Postcode Manual (2009). He served from 1995 to 2007 as an elected leader of the USPS Mailers Technical Advisory Committee (MTAC). His company, Lubenow and Associates, can be reached at lubenow@msn.com.

Joe Lambert

Joe Lambert is an Analyst at Allies Computing Ltd, a company specialising in Address Management. Through his role he has worked with the UK address database for many years and more recently with various international address databases. He has been involved in the development of the UPU's Postal Address Standards and is currently working on a Masters degree in Geographical Information Systems where he is researching the technological and social implications of using Cloud Computing for manipulation of large address databases.

Carl Anderson

Carl Anderson is an Assistant Director for Fulton County, Georgia. He has over 20 years experience in working with local governments in addressing, GIS and information management. He is a co-chair of the U.S. Address Standard Working Group, and serves on the Board of Directors of the Urban and Regional Information Systems Association (URISA).

Sara Yurman

Sara Yurman is Director of Information Services at Spatial Focus, Inc. She is a co-author of the draft United States Thoroughfare, Landmark and Postal Address Data Standard. She is a principal in Spatial Focus, Inc., and has over 20 years experience in working with local governments in addressing, GIS and location information.

Ruth Jones

Ruth Jones is the USPS, Program Manager, USPS®, Intelligent Mail and Address Quality at National Customer Support Center (NCSC) in Memphis, Tennessee. She has 34 years of Postal experience and has worked in Address Management since 1987. Her primary focus is address quality in regards to the national address database and ZIP Code administration. She currently serves as chair for the Addressing Work Group of the Universal Postal Union (UPU), which published the S42 standard, International Postal Address Components and Templates the group is in the process of developing S53 standard, Exchange of Name and Address Data.