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IMPLEMENTATION OF SDI SPECIFICATIONS APPLIED TO MULTIPURPOSE CADASTRES IN URBAN AREAS – A PROPOSAL FOR BRAZILIAN CARTOGRAPHY STRUCTURING

Implementação das Especificações da IDE Aplicado ao Cadastro Multifinalitário nas Áreas Urbanas – Uma Proposta para Estruturação da Cartografia Brasileira

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ABSTRACT

This paper aims to discuss cartographic cadastre possibilities through an NSDI (National Spatial Data Infrastructure) action plan, as proposed by the Planning, Finances and Administration Ministry through CONCAR (National Commission of Cartography) as it refers to Brazil's cadastre system. Brazil's SDI was established in 2008 to create standards and rules for spatial data sharing. However, to distribute spatial data, it is necessary to create a structure of available tools and specified services. The goal of this research is to implement a data distribution network of multipurpose cadastres in urban areas by proposing the structure of data and metadata, verifying its analysis with geo-services in OGC (Open Geospatial Consortium) standards through web-mapping applications, and integrating municipal cadastre administration.

Key-words: SDI, Multipurpose Cadastre, Cadastral Cartography, Geo-Services.

RESUMO

O presente trabalho visa discutir as possibilidades de estruturação da cartografia cadastral proposto do plano de ação do INDE (Infraestrutura Nacional de Dados Espaciais), proposto pelo Ministério de Planejamento, Orçamento e Gestão através da CONCAR (Comissão Nacional de Cartografia), voltado para o sistema cadastral do Brasil. A IDE no país foi estabelecida em 2008 para padronizar e normatizar o compartilhamento dos dados espaciais. Porém, para a distribuição dos dados espaciais é necessário uma estrutura que disponibilize ferramentas e serviços específicos. A pesquisa tem como objetivo apresentar a implementação de uma estrutura de distribuição de dados do cadastro multifinalitário aplicado em áreas urbanas, propondo a estruturação dos dados e metadados, e proporcionando sua análise a partir de geo-serviços nos formatos propostos pela OGC (Open Geospatial Consortium) utilizando aplicações web mapping visando sua integração com os sistemas de gestão cadastral dos municípios.

Palavras chaves: IDE, Cadastro Multifinalitário, Cartografia Cadastral, Geo-Serviços

1. INTRODUCTION

In Brazil, there are basically two types of cadastres—rural and urban. The cadastre of rural properties is the responsibility of INCRA (National Institute for Colonization of Agrarian Reform). The 2001 publication of Law No. 10267 greatly improved the registration of rural properties. This law led to the systematic identification of rural properties, allowing the development of the National Registry of Rural Properties (CNIR) and gradually enabling the geo-referencing of property to their technical standards. This action created a methodology for the regulation and standardization of cadastral maps in rural areas by developing a geospatial data infrastructure, which in the future will enable the integration of a public cadastral record.

In urban areas, the cadastral register is the responsibility of local municipalities. Unlike rural areas, there is no specific legislation regulating cadastres in Brazil's urban areas. Urban real estate cadastres are only mentioned in their municipal tax codes, and only for the strict purpose of taxation (BRANDÃO; SANTOS FILHO, 2008). In some municipalities, the cadastre has been the basis for the implementation of a multifunctional geo-process system for linking data from different departments.

The Ministry of Cities, recognizing the advantages of deploying multipurpose cadastres, has recently developed training programs for municipal agents to address the lack of public policies on this issue. The result of this initiative was the publication of the Guidelines for Multipurpose Land Registry through Ministerial Decree No. 511/2009. This effort was coordinated with the national cadastral community.

Although, in recent years, the country has gradually advanced toward the implementation of a cadastral model implementation based on cadastre and property registration, there is still no public agency with legal responsibility for cadastral measurements.

There is no unified, standardized, multi-functional and modern public registry with a record of all the technical, legal and graphic data of urban real estate, land and related improvements. Furthermore, we have no technical standards in place to develop such as cadastre in urban areas (HASENACK, 2008) (FIG, 2006).

The United Nations and the International Federation of Surveyors (FIG) suggested in the Bogor Declaration on Cadastral Reform (1996) that the cadastral spatial model (usually a cadastral map) should be the plan of fundamental information within an SDI (Spatial Data Infrastructure), allowing the integration of different forms of spatial data (United Nations / FIG, 1996). In Brazil, the National Spatial Data Infrastructure (NSDI) was established by Decree No. 6.666 of 2008.11.27.

Given these initial considerations, this paper aims to present the implementation of a data distribution structure of multipurpose urban cadastres by suggesting the structure of data and metadata and providing an analysis of geo-based services, as suggested by OGC (Open Geospatial Consortium), through the integration of web mapping applications with the system management of cadastral municipalities. Because this document is a theoretical construction, we present a proposal for structuring the cadastral maps, normative data, metadata and geo-services specifically for an urban territorial cadastre.

2. SDI – SPATIAL DATA INFRASTRUCTURE

An SDI is a set of policies, standards, organizations and technological resources that facilitates the production. Also the access and use of geographic information its products (MANISA & NKWAE, 2007). An SDI allows quick access to consistent data on the economic, social and environmental status of a country.

A major objective of SDI is to reduce the duplication of work in pursuit of data. This objective is achieved through the standardization and sharing of data systems.

According to Clausen et al. (2006), the development of an SDI is often a fragmented organizational environment requiring a high level of inter-agency collaboration. Different organizations need to work together to record, store, use and share data, as well as make these data available to society.

This collaboration becomes unfeasible when some institutions refuse to adopt data sharing policies (for public data, not personal or individual data) for fear of losing independence and control.

The process of building an SDI starts with the standardization of the elements to be shared. Subsequently, a connection is made (creating a communication infrastructure) between the institutions, their performance is integrated through mutual cooperation, and a network is finally created with external users, as shown in Figure 1.

2.1 SDI in Brazil

In Brazil, the agencies responsible for coordinating the SDI are CONCAR (National Commission for Cartography), IBGE (Brazilian Institute of Geography and Statistics) and the Ministry of Planning, Budget and Management. The objectives of the implementation of this public policy (INDE, 2010) are as follows:

1. to promote proper planning in the generation, storage, access, sharing, dissemination and use of geospatial data;
2. to promote the use and production of geospatial data by federal, state, county and municipal public agencies using standards and regulations approved by CONCAR;
3. to avoid the duplication of efforts and wasted resources in obtaining geospatial data through the dissemination of the documentation (metadata) of available data in all federal, state, county and municipal entities and public agencies.

The implementation of the NSDI is being accomplished through a plan of action that established goals and objectives to be achieved through three cycles with the following deadlines: Cycle I, 2009 to 2010; Cycle II, 2011 to 2014; Cycle III, 2015 to 2020.

According to Najar et al. (2006), some points should be taken into consideration when designing a national SDI. It is necessary to analyze the geography, history and politics of the country, define the roles of the coordinating agencies and mediators, and determine a government policy for shared data (intellectual property, privacy and estimates of data to be shared). The purpose of the SDI is to integrate the geospatial data of the Brazilian government, as

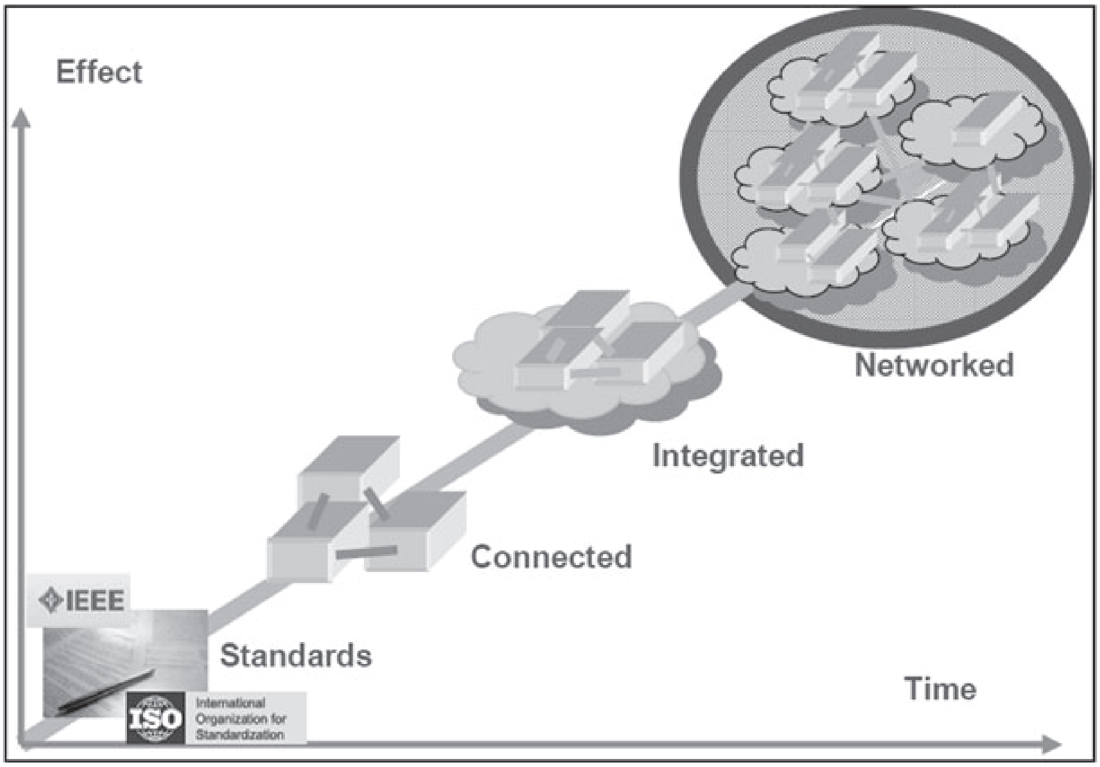


Fig. 1 - Steps for an SDI. Source: Oosterom et al. (2009).

well as private producers and sponsors, so that the data can be easily located, accessed and exploited for various uses by any customer with Internet access. These geospatial data will be cataloged by their respective metadata and published by their producers/maintainers. The availability of data, metadata and geospatial information services via the Internet, called Geospatial Web Services, is made possible through the use of public international protocols that allow access to geospatial information in a simple, flexible, comprehensive and integrated fashion without any specialized knowledge. (CONCAR, 2010).

2.3. SDI and Cadastre Data

The first step in enabling the integration of cadastres to an SDI is defining the standards for data and metadata, as well as establishing policies and updating access to spatial data. Thereafter, the descriptive data associated with this task makes it possible to classify them.

In Europe, the INSPIRE Project proposes standards for SDI cadastre integration, especially the specifications of the cadastral unit in the plots. These specifications have been created from consultations between the institutions of the participating countries. The surveys aimed to identify the main characteristics of cadastral systems in each country. They also analyzed the use of the cadastral parcel in the infrastructure of each country in terms of the accessibility and availability of data. The cadastre data are used as the basis for other issues of compliance with INSPIRE and are considered a prerequisite for the integration of other subjects.

The specifications on the cadastral parcels, however, are not intended to reaffirm the concepts of ownership and related rights inherent to the realities of each country but rather focus solely on the geometrical aspects (TWGCP, 2009).

2.3.1. Cadastral Structure

The structuring of an SDI is accomplished by organizing data, structuring metadata and implementing geospatial services via the Internet, as shown in Figure 2.

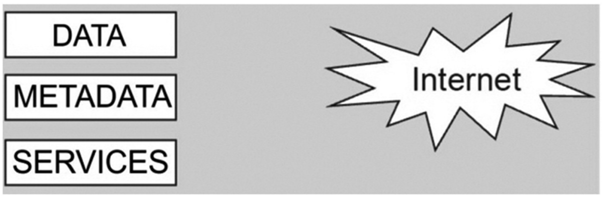


Fig. 2 - Structuring of an SDI. Adapted: Garcia, J. M, Soriano, L. I. V. (2006).

The geospatial data is the information produced by different public and private agencies, such as cartographic databases, special thematic maps, satellite imagery, orthophotos, topographic surveys and many others. Metadata is information that describes the data. The geospatial services follow the standards, rules and procedures defined by the OGC (Open Geospatial Consortium), an international organization that brings together public and private research institutions and companies belonging to different areas of technology and related spatial information and mapping. These services are available via the Internet and free software (Garcia, J. M, Soriano, LIV, 2006) and (FSF, 2012).

2.3.2. Structuring of Data for Cadastral Cartography

Cartography has always been used for many applications. A cartographic pursuit in which the object of study is the piecemeal unit, with an emphasis on the absolute representation of the defining points of a parcel of land is defined as Cadastral Cartography. The systematic survey of a certain portion of land in a given territory can be represented by plants, charts or cadastral maps.

The main goal of the Cadastral Cartography is to define, organize and present information of landed property in its various aspects for different users.

The appropriate tax information coming from Cadastral Cartography should be governed by a series of bindings, obtained through a topographical survey and linked to a Municipal Cadastral Reference Network, which is in turn linked to the Brazilian Geodetic System (SIRGAS-2000) to allow for notarized registration, correlation or corrections. This association would give greater legal certainty to the cadastre of local governments and would be the first step in the development of a SICART (Cadastre System and Land Registry).

The national guidelines of a multipurpose territorial cadastre include a proposal for cadastral cartography with the following parameters:

- cadastral survey to identify geometric plots of land referred to the Brazilian Geodetic System (BGS);

- deployment, maintenance, repair and inviolability of landmarks by the municipalities linked to BGS, according to the recommendations of the IBGE;
- search and location of works and new subdivisions referred to the BGS, supported by the corresponding local landmarks;
- use of the Universal Transverse Mercator (UTM) projection system;
- vertices that define the boundaries of each parcel must be a closed geometric figure.

2.3.3. Structuring Metadata

The 2009 Profile of Brazil Geospatial Metadata Profile (MGB), based on ISO 19115/2003, defines all the metadata standards used in the NSDI.

2.3.4. UML – Unified Modeling Language

Since the inception of object orientation systems, designers and developers recognized that the lack of standardized notation hindered the modeling requirements necessary for implementing software. Between the 1980s and 1990s, two methods were developed independently of each other and gained acceptance by designers—the Booch Method, developed by Grady Booch, and the OMT (Object Modeling Technique), developed by James Rumbaugh. Through the support of several technology companies, these methods were merged in 1997 to create the UML (Unified Modeling Language) (FURLAN, 1998).

The UML allowed the user to specify, visualize, document and build artifacts for a specific system, which could then be adopted throughout the development life cycle of a project through different implementation technologies. The following definitions illustrate all the concepts: “The UML is a modeling language, not a methodology.” (FURLAN, 1998). “The UML is a standard diagramming notation. The UML is not a method of analysis or object-oriented design; it is just a notation.” (Larman, 2004).

According to Horstmann (2007), the typical approach of object-oriented design derives from the functional specifications of a program for its implementation. With these specifications, we can document classes and their relationships by using artifacts from UML diagramming.

According to Silva (2007) and Guedes (2009), because of innovations in UML-2, new applications, particularly models that handle spatial data, that meet the demand of industry software engineering and other technology segments have emerged from its use.

In summary, several aspects are involved in modeling with UML, and these aspects include the constructors of diagram language, such as classes and subclasses; associations; multiplicity of associations; organizations, such as by class, aggregation and composition; instantiation; specialization; generalization; packages; and sub-packages. All of the concepts and features are portable and can be entirely implemented in the preparation of complex structures for an spatial data infrastructure.

The metamodel of UML-2 has been enhanced in order to cover the principles of design flexibility in presenting modularity, division of layers, partitioning, extensibility and reuse. However for this metamodel, the MOF (Meta Object Facility) was adopted by the OMG (Object Management Group) to define metadata and represent them as objects to the CORBA standard. A MOF metamodel defines the abstract syntax of the metadata representation of a MOF model. Two main packages—EMOF (Essential) and CMOF (Complete)—are handled directly by the core of the UML.

The infrastructure of UML-2 defines the basic constructs of its features and allows it to adapt to specific areas. Infrastructure is defined by the library infrastructure, which in turn meets the requirements for (a) defining a metalanguage core that can be reused to define a variety of metamodels, including UML, MOF and CWM (Common Warehouse Model); (b) architecturally aligning UML, MOF, and XMI so that the exchange between the models is fully supported; and (c) allowing the customization of UML through profiles and the creation of new languages based on the same core of the UML meta.

The package profile defines the mechanisms used to adapt the existing metamodel platforms to specific areas. A profile must be based on a metamodel, such as UML, and is not very useful alone. The use of profiles allows users to create “dialects” of the UML so that they are better suited to development technologies adopted by a particular company for its business area. Furthermore, the use of profiles allows the adaptation of the UML for the

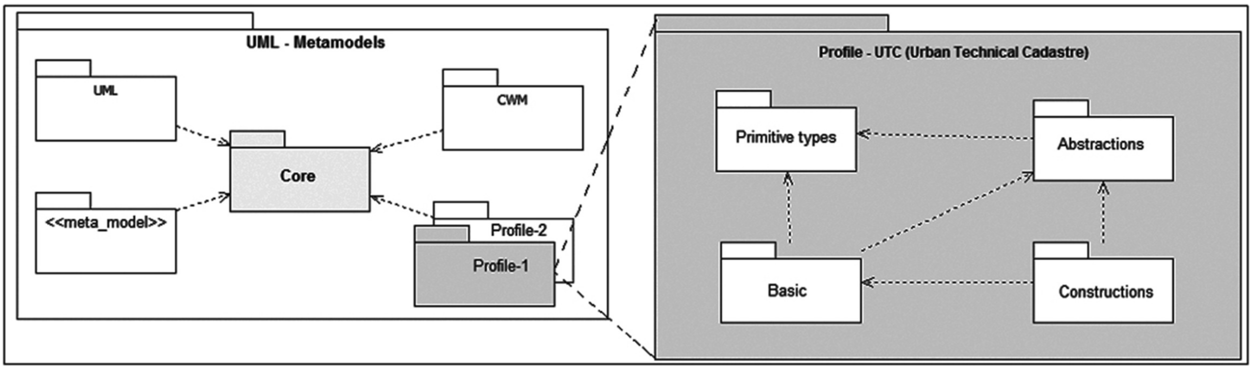


Fig. 3 - Shows the diagram of the UML-2 infrastructure.

development of new technologies without the need to change the language of the core. In previous versions, the use of profiles was not entirely suitable for certain technologies that did not follow their innovations or that were not compatible with some of its features.

2.3.5. OMT-G: Modeling with Geographic Extent

Borges et al. (2001 and 2005) introduced geographical concepts, based on the concepts of UML diagramming classes, in order to increase semantics capacity and thus reduce the gap between the mental space model and the representation model that is commonly used. Therefore, the OMT-G established concepts to model the geometry and topology of spatial data, supporting the “whole-part” topological structure, network structures, multiple views of objects and spatial relationships. Furthermore, the model allows the specification of alphanumeric attributes and the methods associated with each class.

The main strengths of the model are the ease with which it can graphically express the requirements of a system and its ability to shape representations containing textual annotations that represent the dynamics of interaction between the various spaced objects. The OMT-G is based on three main concepts: classes, relationships and the integrity constraints of space. Classes and relationships are the basic concepts used to create application schemes with OMT-G. Thus, the OMT-G uses three different diagrams in the design process of a geographical application.

The first, and most common, diagram is the class diagram in which all classes are specified, together with their representations and relationships. From this diagram, it is possible to derive a set of spatial data integrity constraints that must be observed in the execution model OMT-G. When the class diagram indicates the need for multiple representations of any class, or when the request involves the derivation of another class, a transformation diagram is constructed.

All transformation processes in the diagram can be specified, allowing for the identification of all methods needed for its implementation. Finally, a presentation diagram should be constructed to provide guidelines for the visual appearance of objects in the application. There may be several visual aspects to any type of data, which allow for the definition of a set of views for each application or group of users.

The implementation of the GeoFrame geographic model is illustrated by Gonçalves (2008), taking into account the “urban cadastre” (UTC) problem. In their approach, various aspects of the documentation and UML diagramming of OMT-G are subject to change for this context. However, because of the diversity of complex structures for the spatial data, coupled with the absence and the lack of detail of the metadata, the GeoFrame geographic model has presented little flexibility for operating in many geographic information systems. (OOSTEROM, 2008)

2.3.6. Services Structuring

The following standards are set by OGC: a) A WMS (Web Map Service) allows users to view, refer to the entities shown in a vector map, superimpose vector raster data in different formats, and coordinate reference systems and projections located on different servers. A WMS requests can be made by a default browser in the form of URLs.

b) A WFS (Web Feature Service) allows users to access, view and even modify (insert, update and delete) all the attributes of a geographic phenomenon represented in the form vector. c) A WCS (Web Coverage Service) refers to a file or data set in matrix format used to represent phenomena with continuous spatial variations. The service allows a WCS to not only visualize data in matrix format but also refer to the numeric value associated with each pixel. d) A CSW (Catalog Web Service) is a specification of the OGC service that lets you publish and access digital catalogs of metadata for geospatial data and services, as well as other information resources (IGN/IDEE, 2008 and CONCAR, 2010). An example of a WMS service with cadastre information of land parcels is the city of Cascavel-PR in Brazil, which can be accessed at http://geoportal.cascavel.pr.gov.br/geoserver/cascavel/wms.

3. PROPOSAL OF URBAN CARTOGRAPHY CADASTRE STRUCTURING

The structuring of an SDI is performed through the regulation and standardization of geographic data. In any mapping performed by public agencies or private entities, it is necessary to follow the rules and standards set by the SDI in order to coordinate the data. Similarly, the metadata must be standardized in order to share data. These services must be provided according to standards established by the OGC (Open Geospatial Consortium).

To achieve this structure, we highlight the following proposals regarding the preparation of data and metadata as well as the delivery of information through geo-services.

3.1. Proposal of Data

The structuring of an SDI, applied to cadastre land in urban Brazil, requires the creation of urban cadastral legislation, thus changing the form of public registration of real estate. In addition to legislation, technical standards must be created in order to define the accuracy of surveys and their standardization.

The data from cadastres for cadastral cartography must originate from digital media, standardized and normalized as per the standards defined by NSDI, referenced through the Brazilian Geodetic System (SIRGAS-2000) and must use the UTM projection. Data must be obtained from topographic and geodetic methods, which provide compatible accuracy compared with the cadastral surveys in urban areas.

In Figure 4, we show how normative base cartographic data are organized according to CNEFE (National Address Cadaster for Statistics-IBGE). The proposal consists of

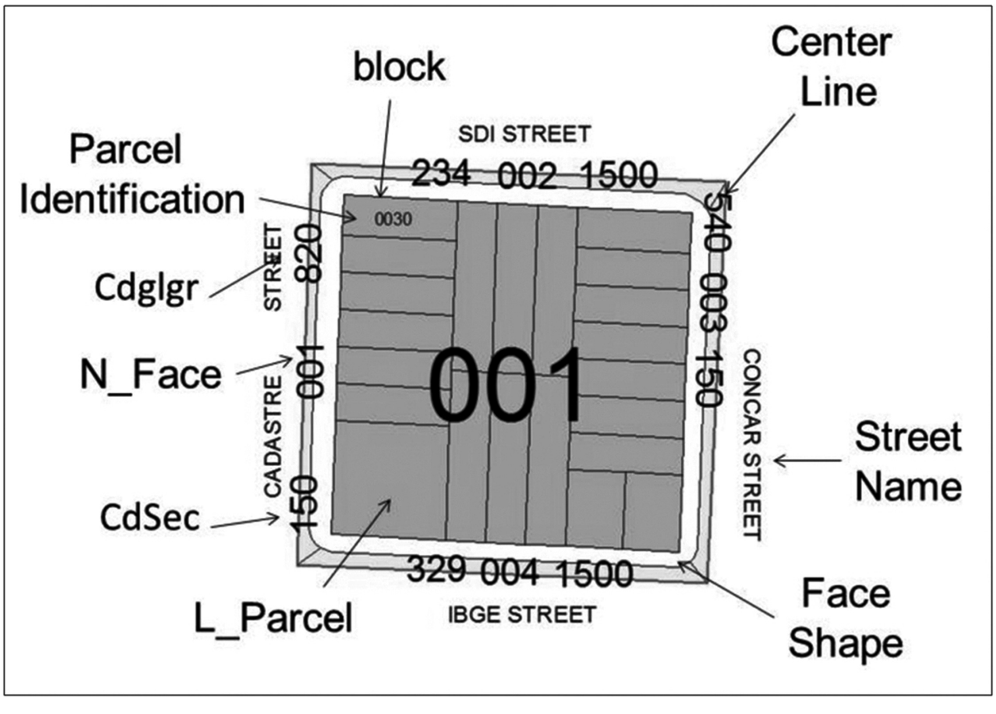


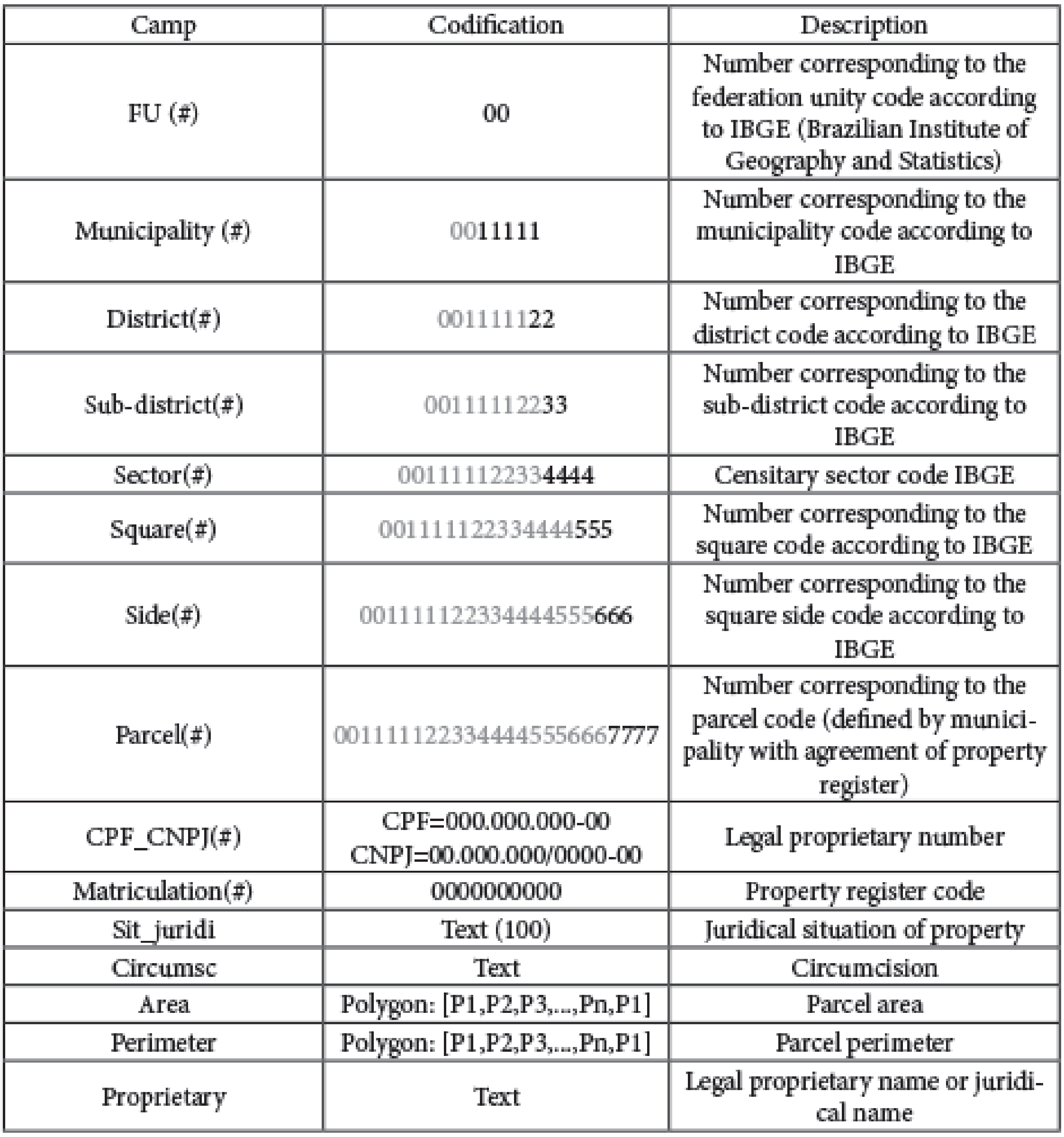
Fig. 4 - Proposal for Urban Cartography Structuring.

features that are created by a graphic information system, organized in the tables (alphanumeric data), each with coding, color, shape trace, thickness and type as described below:

- **FEDERATION UNITIES (SHAPE)**
- **MUNICIPALITIES (SHAPE)**
- **DISTRICTS (SHAPE)**
- **SUBDISTRICTS (SHAPE)**
- **SECTOR (SHAPE)**
- **SQUARE SIDE:** Polygon corresponding to square side and geocodifier;
- **N_FACE:** Text corresponding to the square side number;
- **AXIS:** Line that represents the axis of all common ground and geocodifier;
- **SECTION:** Corresponding line to the square side and geocodifier;
- **STREET NAME:** Text with common ground toponymy;
- **SQUARE:** Polygon that defines the square;
- **N_SQUARE:** Text corresponding to the square number;
- **L_PARCEL:** Border that defines the Parcel, polygon contour of Parcel;
- **CADASTRE IDENTIFICATION:** Text corresponding to the number of cadastre identification

After defining the graphical features, it is necessary to structure the relevant tables to store the cadastre data. We proposed the following organization, with tables Parcel, Square Side (Face) and Axis. Among the initially elaborated 15 attributes are 10 key attributes (#) that are essential for parcel table characterization. This organization allows the individualization of each record from the database as well as its relationship, as shown in Chart 1. This organization also detaches the union of 8 attributes to identify a parcel, along with the 25 generated

Chart 1. Parcel Table.



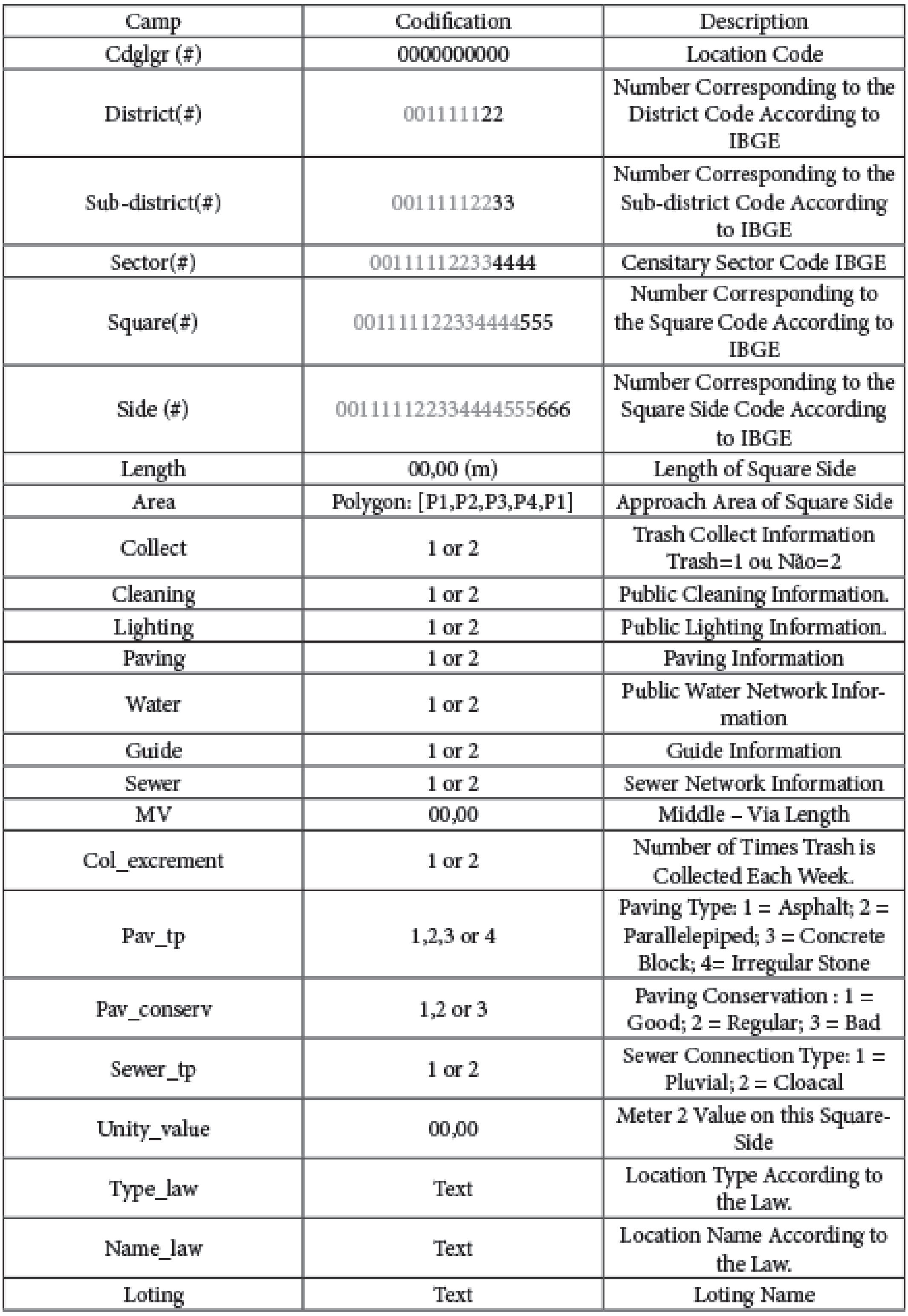
Camp	Codification	Description
FU (#)	00	Number corresponding to the federation unity code according to IBGE (Brazilian Institute of Geography and Statistics)
Municipality (#)	0011111	Number corresponding to the municipality code according to IBGE
District(#)	001111122	Number corresponding to the district code according to IBGE
Sub-district(#)	00111112233	Number corresponding to the sub-district code according to IBGE
Sector(#)	001111122334444	Censitary sector code IBGE
Square(#)	001111122334444555	Number corresponding to the square code according to IBGE
Side(#)	001111122334444555666	Number corresponding to the square side code according to IBGE
Parcel(#)	0011111223344445556667777	Number corresponding to the parcel code (defined by municipality with agreement of property register)
CPF_CNPJ(#)	CPF=000.000.000-00 CNPJ=00.000.000/0000-00	Legal proprietary number
Matriculation(#)	0000000000	Property register code
Sit_juridi	Text (100)	Juridical situation of property
Circumsc	Text	Circumcision
Area	Polygon: [P1,P2,P3,...,Pn,P1]	Parcel area
Perimeter	Polygon: [P1,P2,P3,...,Pn,P1]	Parcel perimeter
Proprietary	Text	Legal proprietary name or juridical name

concatenated characters, the proprietary identification and the cadastral matriculation of the public institution.

For the square side table, there are 24 attributes with 6 attributes designated as key (#), as illustrated in Chart 2. These attributes are utilized to identify and maintain a structure and urban equipment diagnosis that is correctly implanted in each square side.

In the axis table, there are 5 key attributes (#), as illustrated in Chart 3. These attributes are adopted to identify the locations and squares according to IBGE-CNEFE data structure.

Chart 2. Square Side Table.



Camp	Codification	Description
Cdglgr (#)	0000000000	Location Code
District(#)	001111122	Number Corresponding to the District Code According to IBGE
Sub-district(#)	001111112233	Number Corresponding to the Sub-district Code According to IBGE
Sector(#)	0011111122334444	Censitary Sector Code IBGE
Square(#)	0011111122334444555	Number Corresponding to the Square Code According to IBGE
Side (#)	0011111122334444555666	Number Corresponding to the Square Side Code According to IBGE
Length	00,00 (m)	Length of Square Side
Area	Polygon: [P1,P2,P3,P4,P1]	Approach Area of Square Side
Collect	1 or 2	Trash Collect Information Trash=1 ou Não=2
Cleaning	1 or 2	Public Cleaning Information.
Lighting	1 or 2	Public Lighting Information.
Paving	1 or 2	Paving Information
Water	1 or 2	Public Water Network Information
Guide	1 or 2	Guide Information
Sewer	1 or 2	Sewer Network Information
MV	00,00	Middle – Via Length
Col_excrement	1 or 2	Number of Times Trash is Collected Each Week.
Pav_tp	1,2,3 or 4	Paving Type: 1 = Asphalt; 2 = Parallelepiped; 3 = Concrete Block; 4= Irregular Stone
Pav_conserv	1,2 or 3	Paving Conservation : 1 = Good; 2 = Regular; 3 = Bad
Sewer_tp	1 or 2	Sewer Connection Type: 1 = Pluvial; 2 = Cloacal
Unity_value	00,00	Meter 2 Value on this Square-Side
Type_law	Text	Location Type According to the Law.
Name_law	Text	Location Name According to the Law.
Loting	Text	Loting Name

Chart 3. Axis Table.

Camp	Codification	Description
Cdglgr (#)	0000000000	Location Code
CdSec(#)	0000000000	Location Section Code
District(#)	001111122	Number Corresponding to the District According to IBGE
Sub-district(#)	00111111 2233	Number Corresponding to the Sub-district Code to IBGE
Sector(#)	001111122334444	Censitary Sector IBG Code

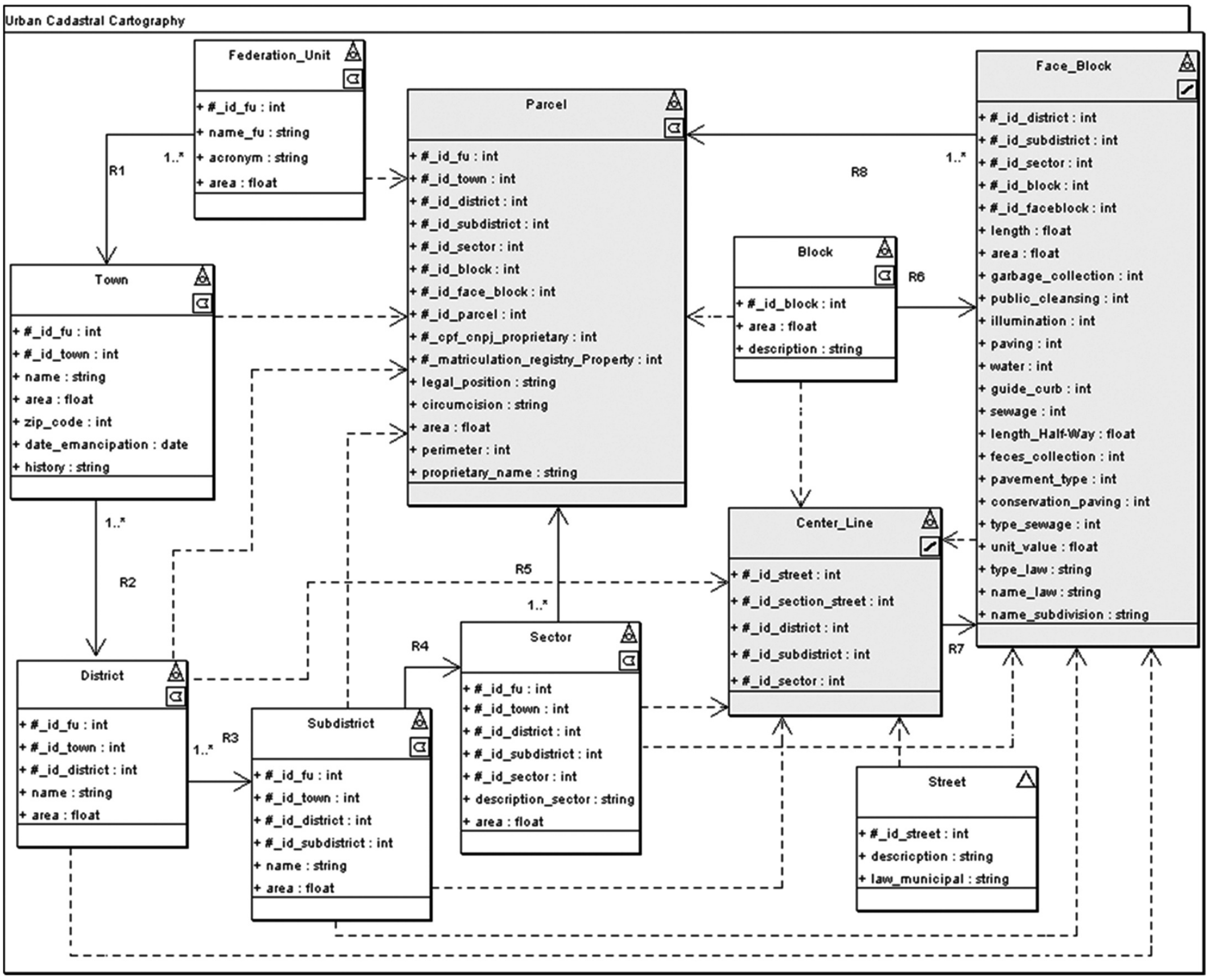


Fig. 5 - Classes Diagram for Data Integration Structure (IBGE-CNEFE and CTU).

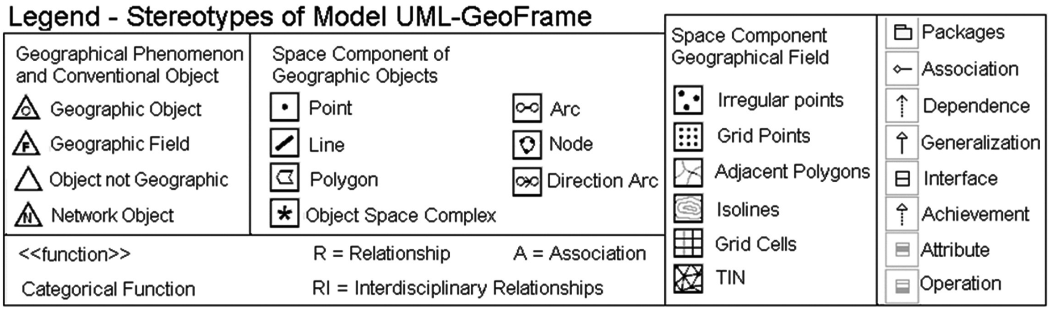


Fig. 6 - Legend of Stereotypes.

3.2. Metadata Proposal

To ensure reliable documentation, it is necessary to initially detect the inclusion of metadata for each subject, as well as to identify the origin and structure of the corresponding data for reliable temporal control. It is crucial, especially for Brazil, that any gap in the structure of spatial data or adequate infrastructure space for the urban cadaster be addressed to enable the portability of previously established standards for the exchange of data and to allow interoperability between the various geographic information systems. (MORAES et. al, 2011)

A new data infrastructure for the Brazilian system of urban cadastre can reduce the conflicts caused by misinformation regarding the ownership rights and subdivision of land. The infrastructure can also serve other technical aspects observed by public officials, especially as a reference for fair and equitable taxation (NEUNZERT, 2010).

Figure 5 shows the diagram for the survey and its final implementation, which illustrates the main classes of CNEFE (Cadaster National Address for Statistics IBGE) and the proposed model for the integrated spatial data infrastructure for multipurpose cadastres. In addition to the attributes that belong to classes, we show the standardized areas of each problem and their relationships, creating a more flexible, multipurpose cadastral model. Figure 6 shows the legend with the stereotypes adopted for the created model.

After creating the diagram, it was possible to automatically generate a physical model of the database, along with the necessary structure for the storage and representation of spatial data. To valid the structure, experiments were performed using standard ESRI (shape files and dbf), PostgreSQL/ PostGIS and MySQL, a proven flexible framework to exchange between the patterns.

3.3. Proposal of Services

The Brazilian Government, through the Ministry of Environment, has developed free software (i3Geo, available at http://www.mma.gov.br) that aims to disseminate geospatial information produced by the federal government. The i3geo is an interface that allows the visualization of geospatial data in different formats. This tool enables the creation of maps, viewing functions, navigation and basic queries. It also allows the user to choose different bases through a list of geo-services in WMS format.

This platform can be used as a basis for the development of future systems, providing a catalog with different geo-services in different formats depending on each user's level of access. Eventually, a geo-certification service should be established between the bodies responsible for cadastre in Brazil: city halls, IBGE, INCRA and notary offices of property.

4. CONCLUSION

This study reviews the contents of technical expertise required in creating the first version of the proposed infrastructure for the data of urban multipurpose cadastres. The SDI provided the initial motivation for joining different issues and complexities in order to assist in the standardization and interoperability of the urban cadastral cartography of Brazil.

In the proposed structure, the municipal administrations would be responsible for updating and managing multipurpose cadastres, through Geo-services, and any registration changes would be validated by the notary's office of property, IBGE and INCRA. Once information is certified, it would be available for different users through a catalog service.

After identifying the public institutions responsible for the production and compilation of geographic data, it is possible to carry out the investigation of existing structures. From the understanding and identification of adopted standards, we made a new proposal for metadata infrastructure for urban cadastral cartography.

For infrastructure development, several aspects were taken into account, including the organization and standardization of metadata for the multipurpose cadastres, thus generating the first results obtained with the proposed infrastructure.

Through UML, the efficacy of language to build class models with geographic representation was affirmed, particularly in the case of OMT-G, where the first structures were implemented for the designed infrastructure. Though stereotypes were successfully adopted in the construction of the proposal, new implementations were needed because of the lack of resources to assist in the construction and representation of urban cadastral systems of reference. Future research should investigate the implementation of such features in order to refine this proposal.

Other needs were detected in the preparation of this article, especially in the standardization of metadata for services rendered by various public institutions. However, this issue will likely be the subject of discussion in subsequent papers.

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