BOUNDARY POINT AND BOUNDARY OF THE CADASTRAL PARCEL AS LADM OBJECTS BY THE EXAMPLE OF A POLISH REAL ESTATE CADASTRE

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Abstract

The Land Administration Domain Model (LADM), enforced with the ISO 19152 standard, is a conceptual model written in the Unified Modeling Language (UML). LADM defines a reference real estate administration model and allows the creation of national profiles. The objective of the Land Administration Domain Model is to unify the way of collecting and storing data relating to real estate at the international level. This article presents the boundary point and the boundary of the cadastre plot as the Land Administration Domain Model objects. The LADM structure has been analyzed, with special regard to the objects being the subject of this research. The attributes provided for the border point in the ISO standard will be compared with the attributes resulting from the Polish law. Attention was also drawn to the similarities and differences in the definition of the boundary of the cadastral parcel.

Keywords: real estate cadastre, boundary, boundary point, LADM

Introduction

The Land Administration Domain Model, (LADM) implemented by ISO 19152 (STANDARD, 2012) is a conceptual model written in the Unified Modeling Language (UML) notation. It defines the reference model of real estate administration and allows to create national profiles. Its aim is to unify the manner of capturing, consistently merging as well as storing data on real properties from various sources at the international level. Although the LADM covers various aspects of land management, it is not a complete model for any country. The structure of the model at a high level of generality allows to formulate the thesis that ISO 19152 should be treated as a metamodel for which each cadastral register will be its instance (BYDŁOSZ et al., 2012). It also means that, depending on the specificity and legal regulations in force in a given country, as compared to the Land Administration Domain Model, more or less significant differences may occur as far as the manner of entering information on real estate is concerned.

Numerous publications have examined the possibilities of implementing these records (STANDARD, 2012) in relation to the real estate cadastre functioning in Poland (BYDŁOSZ, 2012a; BYDŁOSZ, 2012b; BYDŁOSZ et al., 2012; GÓŹDŹ, VAN OOSTEROM, 2016; GÓŹDŹ, PACHELSKI, 2014), in Europe (ALEKSIĆ et al., 2005; ELIA et al., 2012; HESPANHA et al., 2009; MADER et al., 2015; POULIOT et al., 2013; STOTER et al., 2013) and in the world (LEMMEN et al., 2010; BABALOLA et al., 2015; FREDERICO, CARNEIRO, 2014; LEMMEN et al., 2015; LI et al., 2012; VAN OOSTEROM et al., 2009; ZHUO et al., 2015). These publications have confirmed that the Land Administration Domain Model formed the basis for the analysis of real estate information systems at the international level.

In order to meet the demands of the INSPIRE Directive, which establishes the spatial information infrastructure in the European Community, Poland has recently seen numerous changes in the functioning of the real estate cadastre (DAWIDOWICZ, ŹRÓBEK, 2011; PIETRZAK et al., 2012; GÓŹDŹ et al., 2014; BUŚKO, 2016a; BUŚKO, 2016b; MIKA, 2017). The key moment was when the amendment to the Regulation on the Register of land and buildings entered into force in 2013 (REGULATION, 2013). It was to contribute to the adaptation of the Polish real estate cadastre to the requirements of interoperability of spatial data sets (BYDŁOSZ, 2015). The Authors of this research paper have undertaken to verify this thesis by assessing the conformity of the conceptual model of the Polish cadastre with the assumptions presented in ISO 19152. Therefore, the

research methodology consist in comparison of Polish legal regulations concerning real estate cadastre with contents of appropriate international standards.

Due to the fact that the basic object of cadastral systems in the world is a parcel, referred to in the LADM as a spatial unit, whose most important spatial attribute are its boundaries determining the extent of ownership right and other rights related to a given real property (HANUS et al., 2013), the analyzes have focused on the concept of the boundary point and the boundary line. The relevant Land Administration Domain Model classes, representing the boundary point and the boundary line, have been discussed. An attempt has been made to find their equivalents in the Register of land and buildings, referred to in Poland as the real estate cadastre. Such an approach allowed both to organize information on the manner of entering the data on boundaries into the national cadastral system as well as to identify differences in relation to the reference model.

LADM structure

The data collected in the Land Administration Domain Model (LADM) are grouped into three packages and one subpackage:

- Party Package,
- Administrative Package,
- Spatial Unit Package,
- Surveying and Spatial Representation Subpackage.

Each of the specified elements consists of a group of classes with certain common attributes. Packages facilitate the maintenance of data sets by various organizations. The full model can therefore be implemented through a distributed set of information systems, each of which handles specific activities related to the maintenance of data and delivery of elements of the model. A generalized example of such a solution includes the Party Package being delegated to the bodies that maintain land and mortgage registers, and the Spatial Unit Package to the authorities that maintain the Register of land and buildings.

The Packages and the Subpackage that make up the LADM, together with their respective classes, are presented in Figure 1. The Party Package includes the classes related to the types of parties and their role in the functioning of the system. The Administrative Package includes e.g. the classes related to property rights and liabilities associated with them. The Spatial Unit Package includes the classes related to spatial elements, such as: parcel, building or premises, as well as their characteristic properties such as type, surface area, cubic volume. As it was highlighted in Figure 1, the Surveying and Spatial Representation Package is the subpackage of the Spatial Unit Package. It includes e.g. the classes representing points, boundaries, transformations and sources of this information.

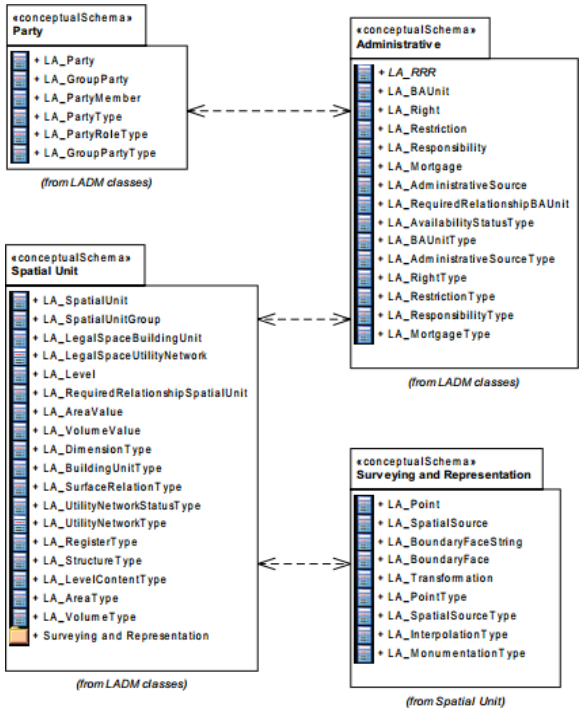

Fig. 1. Packages and subpackage (with appropriate classes) making up LADM.
Source: (STANDARD, 2012).

In the Land Administration Domain Model, four basic classes can be distinguished. The first one is the "LA_Party" class, representing the parties. This class is part of the Party Package. The second basic class is "LA_RRR" (rights, restrictions, responsibilities), which is part of the Administrative Package. The next basic class "LA_BAUnit" comes from the same package - in the Polish nomenclature, it corresponds to the register unit of land, buildings or premises, respectively (BYDŁOSZ, 2012). The last basic class is the cadastral parcel - "LA_SpatialUnit" derived from the Spatial Unit Package. The structure of the basic LADM classes is illustrated in Figure 2.

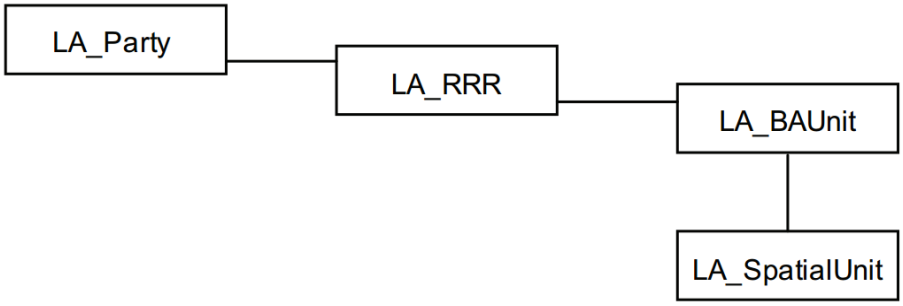

Fig. 2. Structure of basic LADM classes.
Source: (STANDARD, 2012).

Point and boundary line as LADM objects

In the context of the analyzes related to the boundary point, special attention should be paid to the Surveying and Spatial Representation Subpackage. The framework of this package consists of four classes: LA_Point, LA_BoundaryFace, LA_BoundaryFaceString and LA_SpatialSource. The relationships between these classes are illustrated in Figure 3.

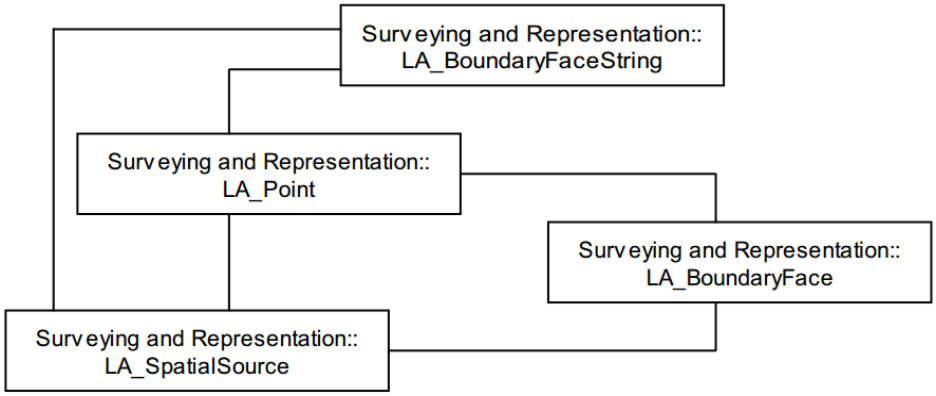

Fig. 3. Surveying and Spatial Representation Subpackage class structure.
Source: (STANDARD, 2012).

The point (LA_Point) is a dimensionless geometric object that represents the location. The boundary, in accordance with (STANDARD, 2012) is a "set representing boundaries of the unit". The concept of the boundary is most frequently used in the context of geometry, in which it constitutes a set of points. The terms "boundary face" (LA_BoundaryFace) and "boundary face string" (LA_BoundaryFaceString) refer to the three-dimensional representation of the boundary of a spatial object, both in horizontal and vertical planes. LA_SpatialSource collects information about the source of spatial data, e.g. field surveys, orthophotomap.

The basic schematic diagram of the Surveying and Spatial Representation Subpackage class structure demonstrated in Figure 3, is extended with the attributes of these classes in (STANDARD, 2012). The relationships between the other classes are also presented. In Figure 4, the elements significant for the determination of the boundary point in the LADM are marked in orange.

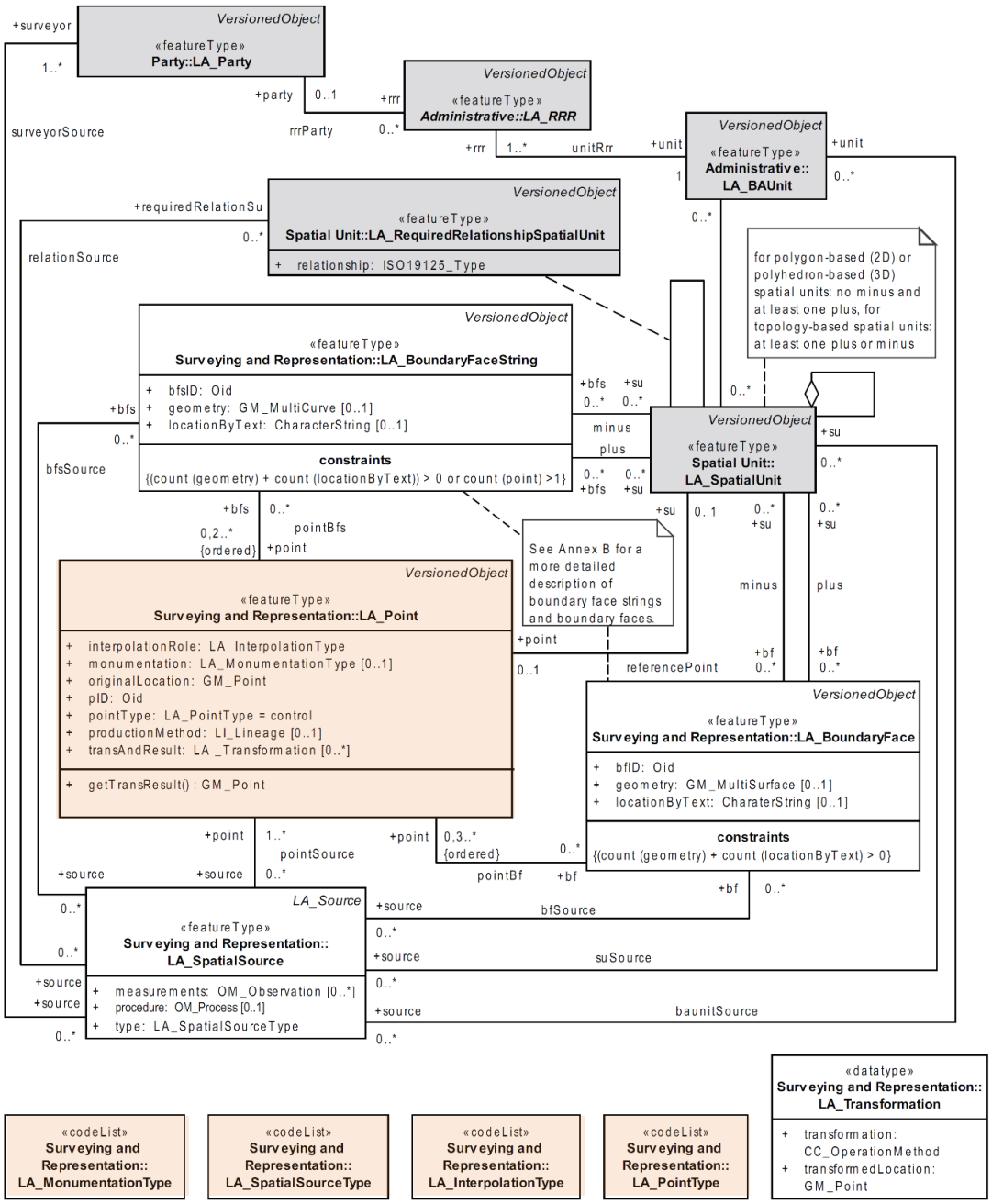

Fig. 4. Content of Surveying and Spatial Representation Subpackage and its relationship with other classes. *Source: (STANDARD, 2012).*

The LA_Point class is defined in Figure 4 using seven attributes and one operation. These attributes describe the characteristic features of an object, whereas operations are services (processes) to be performed by a given class subject to a command of another class (PARZYŃSKI, CHOJKA, 2013). The operation "getTransResult()" returns the transformed point (GM_Point). In order to organize the information contained in Figure 4 and in the content of ISO 19152 (STANDARD, 2012), Table 1 demonstrates the attributes of the LA_Point class together with their description, type of value and multiplicity.

The first attribute describing the point as the object of the Land Administration Domain Model is "estimatedAccuracy", which should be understood as an absolute (external) accuracy of location. Based on the multiplicity, it can be concluded that this attribute does not need to be specified for each point. One point can be assigned a maximum of one attribute value of the DQ_AbsoluteExternalPositionalAccuracy type. The value of this attribute can be affected by many other classes, such as: type of the survey (MethodType), type of the procedure used (EvaluationProcedure) or time (DataTime).

Another attribute is "interpolationRole" (LA_InterpolationType). This element defines the role of a point in the structure of a given straight or curved line. The values of this attribute can adopt a value from a strictly defined list.

Table 1. Attributes of LA_Point class of Surveying and Spatial Representation Subpackage of LADM.

ATTRIBUTES OF LA_POINT CLASS				
o.	**NAME**	**DESCRIPTION**	**VALUE TYPE**	**MULTIPLICITY**
1	estimatedAccuracy	Estimated accuracy of point location	DQ_AbsoluteExternal PositionalAccuracy	0..1
2	interpolationRole	Role of the point in struture of straight or curved line	LA_InterpolationType	1
3	monumentation	Monumentation type	LA_MonumentationType	0..1
4	originalLocation	Coordinates calculated based on surveys and observations	GM_Point (type from ISO 19107)	1
5	pID	Point identifier	Oid	1
6	pointType	Point type	LA_PointType	1
7	productionMethod	Lineage	LI_Lineage	0..1
8	transAndResult	Transformation and transformed location	LA _Transformation	0..*

Source: Own study based on (STANDARD, 2012).

The class defining the list is called the enumeration class and receives the stereotype <<codeList>>. This stereotype occurs when a user working with the database is able to independently extend the list of available attribute values. The stereotype <<enumeration>> is assigned to the classes for which the list of values defined in the scheme is final, not extensible. It can therefore be assumed that the exemplary enumeration lists proposed in (STANDARD, 2012) are assigned the stereotype <<codeList>>. When implementing the Land Administration Domain Model in a given country, users must define their own values, compatible e.g. with applicable legal regulations. Such lists, containing permissible values of attributes, will be closed - the stereotype <<enumeration>>. The existence of enumeration classes in the LADM is confirmed in Figure 4.

The standard ISO 19152 (STANDARD, 2012) also provides examples of attribute values. Figure 5 illustrates exemplary attribute values for the Surveying and Spatial Representation Subpackage classes.

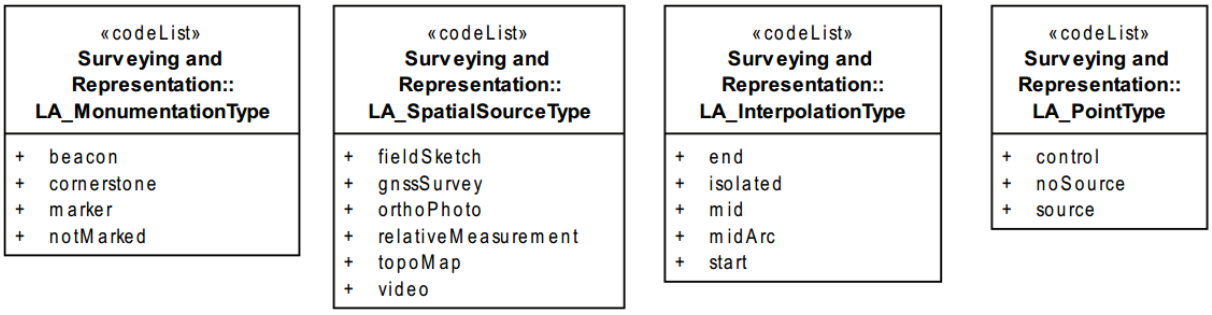

Fig. 5. Exemplary enumeration classes with proposed attribute values of Surveying and Spatial Representation Subpackage
Source: (STANDARD, 2012).

For the analyzed LA_InterpolationType attribute, the point can have the following functions in the line structure: beginning, intermediate point or end of a given line. Each point must have the value of this attribute assigned. The information about the type of monumentation of a given point has been saved in the LA_MonumentationType attribute. This parameter can inform about the type of the monumented boundary marker, e.g. a boundary stone, a metal pipe, and also can provide information on whether the monumentation has been performed at all. For the LA_MonumentationType attribute, the enumeration class is created. In the Land Administration Domain Model, various types of points can be captured, e.g. boundary points, control points, turn points of land use type. The point type is distinguished based on the LA_PointType parameter. Each point must have its type specified; this type is selected from a previously prepared enumeration class.

The mandatory information about the point which must be entered into the LADM are the coordinates of this point "originalLocation" represented by the class (GM_Point), created based on the standard PN-EN ISO 19107:2010 Geographical information - Spatial Scheme (STANDARD, 2010). An obligatory parameter is also the identifier of the point - "pID".

As it is set out in (STANDARD, 2012), the LADM includes the modeling of both acts (LA_Source) and states of the objects using the "VersionedObject" class. In addition to the model based on acts and given states, it is also possible to specify the lineage between spatial units. This is the case e.g. during the subdivision of a cadastral parcel, when new spatial units are parceled out from an existing unit. Such relationships can be saved in the "productionMethod" attribute (LI_Lineage value type). If it is necessary to carry out transformation of the coordinates of a given point, the information about the transformation performed and its results are saved in the "transAndResult" attribute (LA_Transformation). There are no restrictions as to the number of transformations to be saved or their results.

Besides the attributes of the LA_Point class, the information collected in the LA_SpatialSource class is significant as well. This class allows to record information about the lineage of a specific object. The LA_SpatialSource class can be identified with a document informing about the source of data (VAN OOSTEROM et al., 2011). In Polish conditions, the equivalent of this class could be a technical report entered into the National Geodetic and Cartographic Documentation Center database (BYDŁOSZ et al., 2012). Detailed attributes of the LA_SpatialSource class are presented in Table 2.

Table 2. Attributes of LA_SpatialSource class of Surveying and Spatial Representation Subpackage of LADM.

ATTRIBUTES OF LA_SPATIALSOURCE CLASS				
o.	**Name**	**Description**	**Value type**	**MULTIPLICITY**
1	measurements	Observations and surveys	OM_Observation, based on ISO 19156	0..*
2	procedure	Surveying method applied	OM_Process, based on ISO 19156	0..1
3	type	Spatial source type	LA_SpatialSourceType	1

Source: Own study based on (STANDARD, 2012).

The "measurements" attribute is based on the OM_Observation value type derived from ISO PN-EN ISO 19156:2013 Geographical information - Observations and surveys (STANDARD, 2013), and contains the actual data from the survey. The "procedure" (OM_Process) attribute records the procedure for data capture. The source type is recorded in the "type" attribute (LA_SpatialSourceType). The values of this attribute are collected in the enumeration class where, according to Figure 5, e.g. field surveys or orthophotomap can be included.

The presented classes of the Land Administration Domain Model form a diagram, based on which individual countries can create their own models of cadastral data concerning the boundary point. The possibility of introducing changes and defining own lists of permissible attributes allows for the integration of the general model with the model of individual countries.

Boundary point as the LADM object on the example of Poland

In appendixes to the Regulation on the Register of land and buildings (REGULATION, 2001), the specification of a conceptual data model of the real estate cadastre was defined. The contents of the specification includes:

- UML application scheme of the real estate cadastre data,
- Real estate cadastre objects catalog,
- Basic Model UML application scheme,
- Basic Model objects catalog.

One of the basic classes of the data model of the Register of land and buildings is the EGB_PunktGraniczny class, which represents the method of capturing information about the boundary point. The diagram illustrating this class is illustrated in Figure 6.

Based on the presented diagrams, certain similarities between the EGB_PunktGraniczny class and the LA_Point class can be noticed. This is due to the international guidelines being taken into account when amending the law in Poland, including the amendment to the Regulation on the register of land and buildings (REGULATION, 2013). Table 3 demonstrates the boundary point attributes derived from the Land Administration Domain Model (STANDARD, 2012) with the corresponding boundary point attributes defined in the Regulation on the Register of land and buildings (REGULATION, 2001).

Table 3. Attributes of LA_Point and LA_SpatialSource classes and attributes of EGB_PunktGraniczny class.

	LAND ADMINISTRATION DOMAIN MODEL (LADM)		REGULATION ON THE REGISTER OF LAND AND BUILDINGS	
	ATTRIBUTES OF LA_POINT CLASS		ATTRIBUTES OF EGB_ PUNKTGRANICZNY CLASS	
0.	NAME	VALUE TYPE	NAME	VALUE TYPE
1	estimatedAccuracy	DQ_AbsoluteExternal PositionalAccuracy	Mean error of boundary point location relative to the first-order geodetic control (BPP)	EGB_BladPolozenia WzgledemOsnowy
2	interpolationRole	LA_InterpolationType	No direct equivalent	
3	monumentation	LA_Monumentation Type	Boundary point monumentation code (STB)	EGB_KodStabilizacji
4	originalLocation	GM_Point	geometry	GM_Point
5	pID	Oid	idPunktu	Boundary point identifier (NRP)
6	pointType	LA_PointType	Boundary order code (RZG)	EGB_KodRzedu Granicy
7	productionMethod	LI_Lineage	No direct equivalent	
8	transAndResult:	LA _Transformation	No direct equivalent	
	ATTRIBUTES OF LA_SPATIALSOURCE CLASS		ATTRIBUTES OF EGB_ PUNKTGRANICZNY CLASS	
0.	NAME	VALUE TYPE	NAME	VALUE TYPE
1	measurements	OM_Observation,	Boundary point location data source (ZRD)	EGB_ZrodloDanych ZRD
2	procedure	OM_Process,		
3	type	LA_SpatialSourceType		

Source: Own study based on (STANDARD, 2012), (REGULATION, 2001).

It can be noticed that most of the attributes of the boundary point presented in ISO 19152 (STANDARD, 2012) have direct equivalents in the Regulation on the register of land and buildings (REGULATION, 2001). This also applies to three attributes which have a key influence on the quality and reliability of the data on boundaries and surface areas of parcels: the mean error of boundary point location (BPP attribute), the boundary point location data source (ZRD attribute) and the method of boundary point monumentation (STB attribute). This is important information as far as the implementation of surveys aimed at assessing the quality of cadastral data performed on a national scale is concerned. These data can be further extended to the international level (HANUS et al., 2018).

According to Figure 6, the above-mentioned attributes have predefined, non-extendable lists of permissible values assigned the stereotype <<enumeration>>, which are presented in the dictionary tables. Interestingly, the information on the accuracy of the boundary point location (BPP attribute) is entered into the database using a natural number between 1 and 6, which corresponds to the specified interval of the mean error of boundary point location relative to the first-order geodetic control (Figure 6). It is also worth noting that the boundary point location data source in Poland (ZRD attribute) is the attribute of the EGB_PunktGraniczny class, whereas in the Land Administration Domain Model this information is conveyed via a separate LA_SpatialSource class, related to the LA_Point class.

Boundary in LADM and in Polish conditions

When entering data on the boundary point into the Polish real estate cadastre, it is possible to identify numerous similarities to the Land Administration Domain Model. However, in the case of the parcel boundary, there are many significant differences. As it is illustrated in Figure 3, the boundary in LADM is represented by the classes LA_BoundaryFaceString and LA_BoundaryFace, forming the structure of the Surveying and Spatial Representation Subpackage. Both the LA_BoundaryFaceString class and the LA_BoundaryFace class are related to the LA_Point and LA_SpatialSource classes. The geometry of the discussed classes is represented via a curve at ground level (LA_BoundaryFaceString) and surface in 3D (LA_BoundaryFace), which is closely related to the lexical definition of these objects contained in ISO 19152 (STANDARD, 2012). Each boundary in the LADM also has its unique identifier. Table 4 presents the basic information about the analyzed classes.

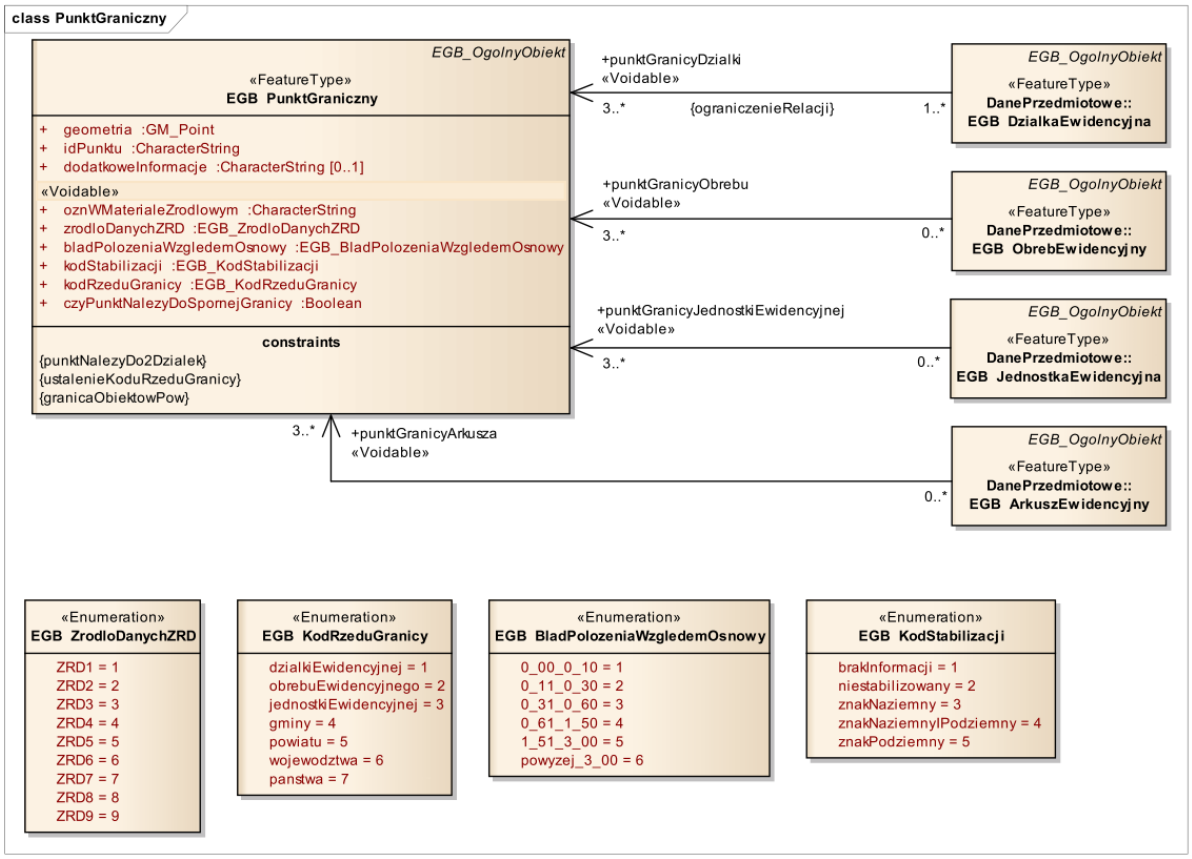

Fig. 6. Diagram of EGB_PunktGraniczny class.
Source: (REGULATION, 2001).

Table 4. Comparison of classes LA_BoundaryFaceString and LA_BoundaryFace of Land Administration Domain Model.

LA_BoundaryFaceString class Geometry: GM_MultiCurve (type from ISO 19107)	LA_BoundaryFace class Geometry: GM_Surface (type from ISO 19107)
Boundary forming part of the outside of a spatial unit. Boundary face strings are used to represent the boundaries of spatial units by means of line strings in 2D. This 2D representation is a 2D boundary in a 2D land administration system. In a 3D land administration system it represents a series of vertical boundary faces where an unbounded volume is assumed, surrounded by boundary faces which intersect the Earth's surface (such as traditionally depicted in the cadastral map).	Boundary face is used in the 3-dimensional representation of a boundary of a spatial unit. Boundary faces are used when the implied vertical and unbounded faces of a boundary face string are not sufficient to describe 3D spatial units. Boundary faces close volumes in height (e.g. every apartment floor), or in depth (e.g. an underground parking garage), or in all other directions to form a bounded volume. The volumes represent legal space (in contrast with physical space).

Source: Own study based on (STANDARD, 2012).

In Poland, according to the Regulation on the Register of land and buildings (REGULATION, 2001), the boundary of the parcel is part of its circumference in the form of a broken line or section, shared by two neighboring parcels or coinciding with the state border – for the parcels adjacent to this border. It should be emphasized that, unlike in the LADM, the legislator did not provide for the necessity to enter individual boundary lines in the form of separate spatial objects into the Polish real estate cadastre. Therefore, the boundary of the parcel is not represented in the database by the appropriate class, as is the case for the boundary point (EGB_PunktGraniczny class). Nevertheless, on the cartographic reports generated from the database, boundaries of parcels exist. They are a graphical representation of the contour of the polygon (GM_Surface) representing the cadastral parcel (object of the EGB_DzialkaEwidencyjna class).

Under the Polish legal regulations, the boundary could be identified with the LA_BoundaryFaceString class. As there is no obligation to register the height of the boundary points of the parcel, it would be impossible to find the equivalent of the boundary in the LA_BoundaryFace class, represented by the surface in 3D. According to (STANDARD, 2012), the boundary (LA_BoundaryFaceString) generally consists of at least two points (objects of the LA_Point class), although the boundary location can also be defined by the text. Then, boundary face string would not be defined by points. However, such a

possibility is not provided for in the case of the Polish real estate cadastre, where the course of the boundary is always determined by the coordinates of the boundary points expressed in the valid rectangular coordinate system (System 2000).

As it appears from Figure 4, the LA_BoundaryFaceString class may be associated with zero or more spatial sources (LA_SpatialSource). This means that the boundary of a spatial unit can be described on one or more spatial sources, on the spatial source creating the spatial unit and on the spatial source creating the neighboring spatial unit. Such a solution could be translated directly into the Polish law. The LA_BoundaryFaceString class may be associated with any number of spatial units or it may not be associated with any LA_SpatialUnit object, as illustrated in Figure 4. In Poland, where the real estate cadastre is maintained as the information system, the boundary being a section or a broken line common for two neighboring parcels will be associated with these two parcels only (HANUS, 2013). An exception to this rule are the boundaries of the parcels which coincide with the state border. Therefore, it can be concluded that the number of objects of the LA_BoundaryFaceString class associated with a given parcel (LA_SpatialUnit) will be equal to the number of the parcels adjacent to it, and in the case of the parcels located at the state border, greater by 1 than the number of the neighboring parcels, as illustrated graphically for four exemplary objects in Figure 7.

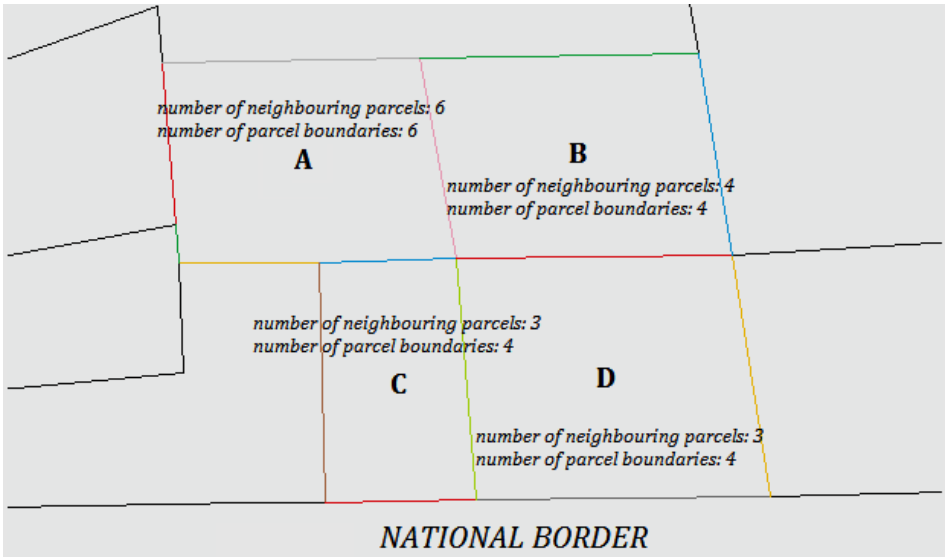

Fig. 7. Graphic presentation of required number of objects of LA_BoundaryFaceString class for exemplary four parcels under Polish legal regulations.
Source: Own study.

The Land Administration Domain Model (LADM) provides for numerous possibilities to enter the spatial data on the boundaries of cadastral parcels. In Annex B to ISO 19152 (STANDARD, 2012), it was pointed out that in many countries a 2D representation is interpreted as a 3D prismatic volume, with no upper and lower bound. Using this interpretation, 2D and 3D representations can be unified. Figure 8 illustrates the basic concept of extending the boundary of the parcel in the vertical plane:

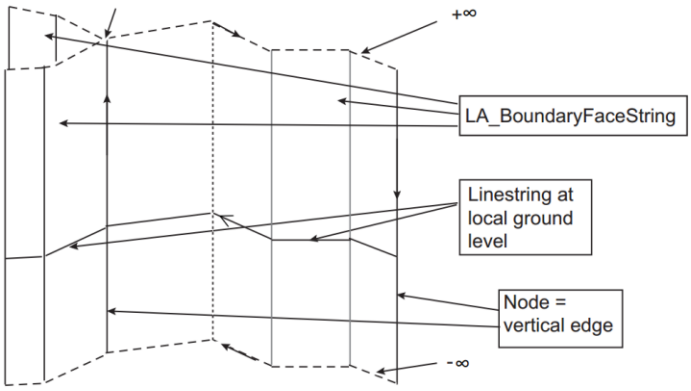

Fig. 8. Boundary face string as boundary of parcel, unrestricted in vertical plane.
Source: (STANDARD, 2012).

So far, the above model has not been applicable in Poland, where the term "three-dimensional real estate" or the "air parcel" has not been introduced yet, although this issue has been the subject of discussion for many years (KARABIN, 2007; KARABIN, 2008; FELCENLOBEN, 2013). Such and other solutions for registering spatial property rights to land apply e.g. in Sweden, Norway or the United States.

Conclusions

The implementation of the Land Administration Domain Model (LADM) was an important step towards ensuring the uniformity of the manner of capturing data on real estate on an international scale. Thanks to the construction of this conceptual model at a high level of generality, it is possible to adapt the profiles of national real estate information systems to local requirements and conditions. It has turned out, however, that this is also the reason for the occurrence of a number of differences in the manner of entering the cadastral data, as demonstrated by the research studies focused on the boundary point and the boundary line of the parcel in the real estate cadastre in Poland.

Based on the comparison of the classes EGB_PunktGraniczny and LA_Point class it was found that all the attributes of the boundary point in the Polish conditions have their equivalents in the Land Administration Domain Model. This means that the Regulation on the Register of land and buildings (REGULATION, 2001) is compliant with ISO 19152 (STANDARD, 2012) in this respect, although three attributes were also noted which, although included in the LADM, were not included in the Polish cadastre. Differences also occur in the method of recording information about the boundary point location data source (ZRD attribute). Such deviations are, however, natural and commonly accepted. The Authors of this research paper claim that they are not an obstacle to conducting spatial analyzes and to exchanging cadastral data at the international level.

The largest discrepancies, however, were identified in relation to the boundary of the parcel. The LADM provides for various options for capturing data on boundaries, both for 2D and 3D cadastre. In Poland, the boundary does not function as an independent spatial object having the appropriate class in the conceptual model. The LA_BoundaryFaceString class, presented in ISO 19152 (STANDARD, 2012), was indicated as the equivalent of the boundary which was possible to be introduced in the Polish conditions. This choice was dictated by the two-dimensionality of the cadastre in Poland. According to the Authors, it is worth noting that the lack of an appropriate class representing the boundaries has had no adverse effect on the functioning of the Register of land and buildings. It can be assumed that the solutions proposed in the LADM could improve the process of distinguishing and visualization of legal, contentious, established or unestablished boundaries. However, any changes in this respect would require a prior amendment of the law and costly activities related to the modernization of the cadastre to adapt the data sets to new requirements.

In summary, the analyzes presented in this research paper allowed to systematize the knowledge on the manner of entering data on boundary points and boundaries of cadastral parcels into the database of the Polish real estate cadastre by comparison with the solutions contained in the Land Administration Domain Model. In addition, based on the provisions of ISO 19152 (STANDARD, 2012), the Authors pointed to the possible directions of changes in the introduction of an additional class representing boundary lines to the conceptual model of the database of the Register of land and buildings. It seems, however, that there will be no need to implement such solutions in practice, at least before the implementation of the 3D cadastre in Poland.

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