LADM – Experiences and Challenges in Implementation

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Key words: Cadastral Data, Land administration, LADM

SUMMARY

Based on the experience in the design and implementation of cadastral information systems in Serbia, Montenegro and Republika Srpska, an entity in Bosnia and Herzegovina, this paper presents activities in the development of LADM based cadastral profiles in these countries and a region. It also demonstrates the implementation of such profiles in practice in the form of technical solution that combines together software for maintaining cadastral and legal data (both alphanumeric data about rights and spatial data on cadastral maps), office management solution and development of on-line services for the citizens, to have an insight into their rights and restrictions. There are three main subsystems of cadastral information system in these countries and the entity: 1) land register containing alphanumeric data about land, buildings, rights and parties 2) cadastre containing graphic data about land parcels and buildings 3) office management for handling requests made by citizens. Software solution includes the functionalities for maintaining cadastral data by employees in mapping agencies and office management module which connects client requests for change of data or issuing the documents, with procedures in cadastre.

The purpose of electronic services is to provide access to these registers to the citizens which can be natural or legal persons. Part of that data is available to all, while more data is available to registered users which are usually legal persons involved in legal issues, such as notaries, banks, ministry of internal affairs, tax administration etc. There are three types of services that are in use: eCadastre service, Web services for information systems of cooperative organizations and geoportal services. eCadastre service provides insight into land register and office management. Users are allowed to view data about rights over their properties. They can also view requests on properties and follow the execution of their requests. Issuing of documents and making request are provided for registered users. Cadastral Web services are intended for use by the information systems of other organizations that use cadastral data, as well as for the work of the eGoverment portal through which online services to clients are executed. Geoportal is established and maintained by the mapping agencies as part of the Spatial Data Infrastructure and provides view of layers of spatial data, including parcels and buildings.

Finally, we make a discussion of possible directions of further development in cadastral domain in this region, based on 3D data acquisition technologies.

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1. INTRODUCTION

The Land Administration Domain Model (LADM) facilitates the efficient set-up of land administrations and it can function as the core of any land administration system (van Oosterom and Lemmen, 2015). Based on the experience in the design and implementation of land information systems (LIS) in Serbia, Montenegro and Republika Srpska entity in Bosnia and Herzegovina, this paper presents activities in development of LADM based cadastral profiles in these regions. It also presents how these profiles have been implemented in the form of a techical solution that operates in cadastral offices and what challenges have been encountered during the process.

The paper is structured as follows: after Introduction in Section 1, Section 2 presents LADM profiles and summarizes the similarities and differences between profiles. It also summarizes the similarities and differences between these three systems, since it influences the development of the profiles. Land information systems and how they are organized have been presented in Section 3. Electronic services for LIS have been presented in the Section 4. It is followd by the discussion on 3D technologies and their influence on LIS in the Section 5. Conclusions and future work have been given afterwards.

2. LADM PROFILES

For the development of the LADM profile for each of these regions, it was necessary to realize the following steps:

- analysis of the requirements defined in appropriate national law and other relevant documents;
- analysis of the international standards in the field of research and literature review;
- analysis of the current land information system (LIS) in specific region, its data dictionary and data sets;
- conceptual modeling to capture concepts in the cadastral domain;
- and finally develop standardized domain model.

2.1 Republika Srpska

In the case of Republika Srpska, for development of LADM profile it was necessary to analyze the Law on Survey and Cadastre (2011), as well as existing LIS and data structure at that time. Existing relational data model was based on standard cadastral concepts. Additional class was related to the paper document called real estate folio which is issued to the parties. The real estate folio consists of four sheets which are marked with different letters. Sheet A contains the information on parcels, sheet B the information on parcel rights, sheet V the information on buildings and parts of buildings, as well as the rights, and sheet G contains the

information on restrictions connected to the spatial units defined in sheets A and V. Profile classes were derived from LADM classes (Govedarica et al, 2011) by adding additional attributes and code lists. Classes of the profile have prefix BHRS (Table 1). LA_SpatialUnitGroup was inherited by class BHRS_CadastralMunicipality that represent cadastral municipality. The LA_SpatialUnit class is used for the modeling of spatial units. Based on this class, new classes were formed that represent parcels and parts of parcels (BHRS_Parcel, BHRS_PartOfParcel), as well as buildings and parts of buildings (BHRS_Building, BHRS_PartOfBuilding). The LA_Party class represents the parties or owners (BHRS_Owner) who have certain rights, restrictions and responsibilities over the spatial units with certain shares. This is represented with the LA_RRR class. The derived classes that describe the rights on parcels, buildings and parts of buildings are BHRS_OwnershipParcel and BHRS_OwnershipBuilding. Restrictions on spatial units are represented in class BHRS_Restrictions. The LA_BAunit class incorporates all the rights, restrictions and responsibilities of one or more parties of a certain number of spatial units, so that the amount of right shares equals 1. This is equivalent with the definition of real estate folio (BHRS_RealestateDocument). As mentioned before, this document consists of four sheets. The modeling of these sheets was done by creating the ASheet, BSheet, VSheet and GSheet interfaces respectively. These interfaces are a collection of all the data that should be in corresponding sheet of the real estate foilo (see Figure 1).

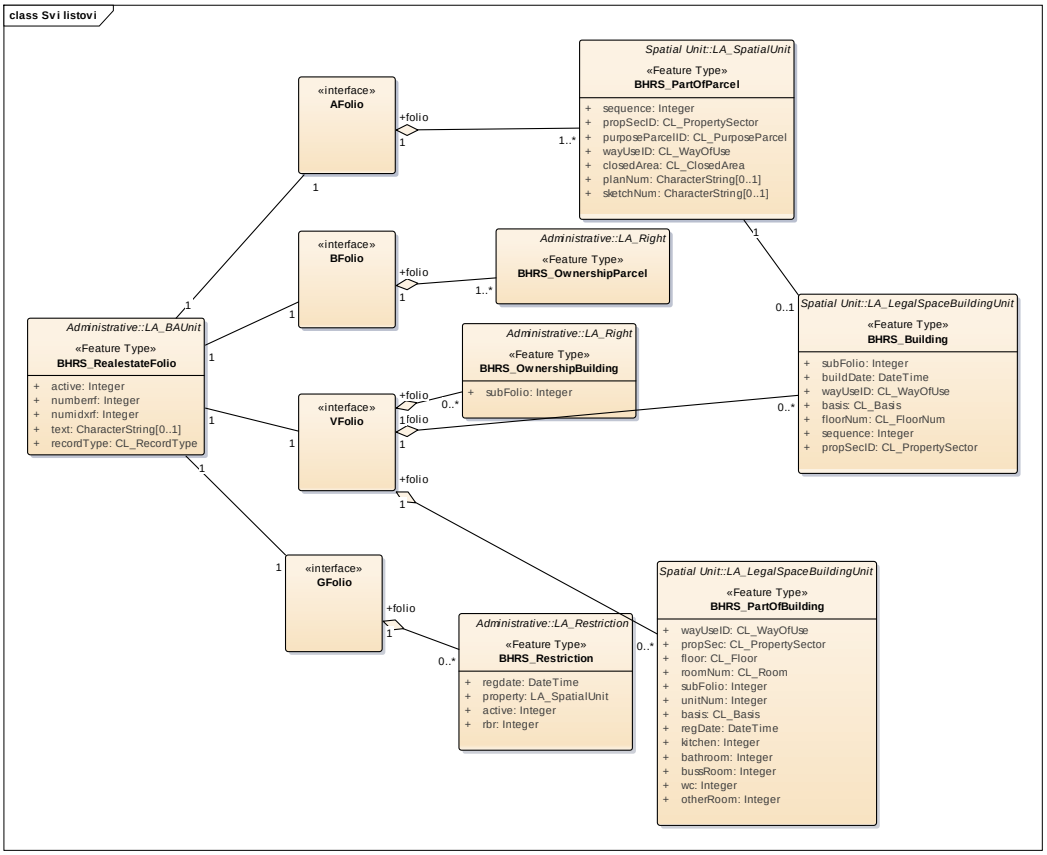

Figure 1. Classes of LADM profile for Republika Srpska

In Republika Srpska there are several types of registers for maintaining cadastral data. The process of establishing a real estate cadastre is still in progress and is not complete for all cadastral municipalities. Cadastral data on some cadastral municipalities are stored in land cadastre (contain data only parcels and rights and restrictions on them). Additional data on parcels, mostly on restrictions over parcels are stored in land register. Some cadastral municipalities already were part of real estate cadastre. In this environment it was necessary to establish new real estate cadastre for all cadastral municipalities. This is carried out through the exposing data to the citizens for verification and existing data. For this purpose, all classes representing cadastral concepts got additional attribute which takes values from code list and indicates the register to which concept belongs.

2.2 Montenegro

The Law on State Survay and Cadastre of Montenegro (2007) also defines the concept of real estate folio. As in Republika Srpska, cadastral data in Montenegro are issued within the real estate folio. Real estate folio consists of four sheets - A, B, V and G. Creation of new standardized data model is described in Radulović et al (2015). Based on the existing relational model at that time and national legislation, it was possible to present the basic concepts in the Montenegrin cadastre (Figure 2). The real estate folio (ListNepokretnosti) contains one or more real estates (Nepokretnost) from A and V sheets, one or more real estate rights (PravaNaNepokretnostima) from B and V sheets and none or more restrictions on real estates (Ogranicenja) from G sheet. One right holder (Nosioci prava) may have no or more rights to the real estates.

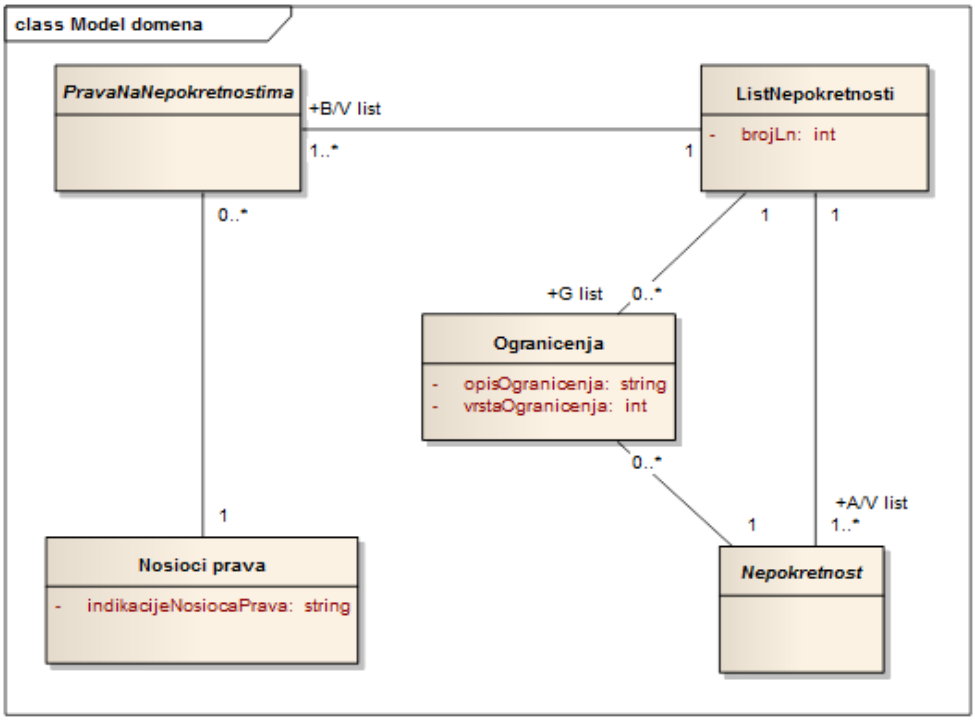

Figure 2. Conceptual model for cadastre in Montenegro

The second step in forming a standardized profile for Montenegro is the comparison of the basic LADM classes and the existing conceptual model. Figure 3 shows the mapping of basic LADM classes to conceptual model for Montenegro. As the LA_Party class describes the right-holders, the appropriate class from the conceptual model is NosiociPrava. Class LA_SpatialUnit describes spatial objects, and it is mapped to the abstract class Nepokretnost. The LA_RRR class describes the rights, restrictions and responsibilities of a real estate. In the conceptual model, classes for the description of rights and restrictions are separated (PravaNaNepokretnostima and Ogranicenja), and both derived from the class LA_RRR. Class LA_BAUnit represents a set of rights, restrictions and responsibilities over one or more real estate so that the sum of rights equals 1. In the conceptual model, this corresponds to the real estate folio, so the corresponding class is ListNepokretnosti. This proved the applicability of ISO19152 standard to cadastral records in Montenegro.

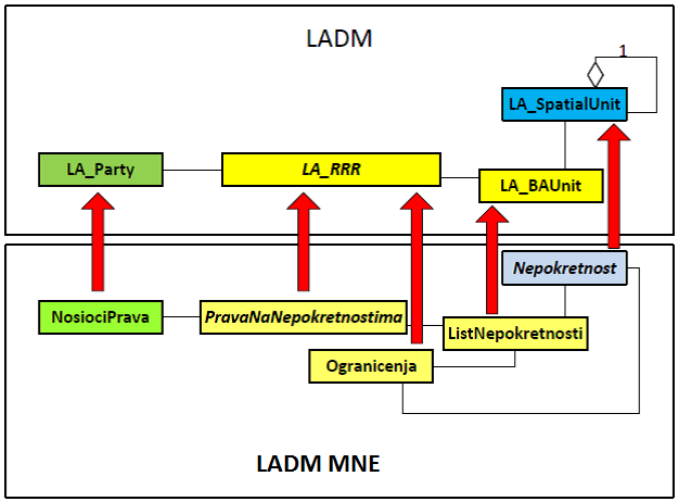

Figure 3. Mapping of LADM classes and classes from Montenegrin conceptual model

The next step was to define LADM profile classes for Montenegro. In the profile, additional attributes or classes were added to fully describe cadastral terms according to national legislation and existing regulations. Profile classes are marked with a prefix MNE (Table 1). In Montenegro there are two types of register for maintaing cadastral data: land cadastre and real estate cadstre. In some cadstral municipalities, especially small villages only data on parcels are maintained. Real estate cadastre exists in cities and bigger settlements. For this purpose, classes for parcels, rights, restrictions and baunits got additional attribute which takes values from code list and indicates whether they belong to land or real estate cadastre.

2.3 Serbia

The land information system in Serbia is regulated by the Law on State Survey and Cadastre from 2009. In Serbia there is also real estate folio as a document that should be issued to the citizens. However, the Law defines a real estate folio as data about a single real property, for example data on one parcel (building or part of building) together with its rights and restrictions. Existing information system for real properties in Serbia was implemented in a

DOS application, based on FoxDbf tables for a significant part of Serbian territory, while a small part of data is stored in a Microsoft Access database. Data models in these two applications differ from each other, with an evident absence of relationships in the FoxDbf database. This makes data migration very difficult because of the lack of data consistency. Data model is based on the old real estate folio definition which says that it consists of four sheets (like in Republika Srpska and Montenegro). This is how the old Law on State Survey and Cadastre and the Registration of Rights on Real Estates Cadastre (1992) defined in the real estate folio. In such situation it was necessary first to create conceptual model for Serbia based on actual law and existing data dictionaries (Figure 4). This procedure together with the development of standardized profile was described in Radulović et al (2017). The real estate folio contains one or more real properties from the A and V sheets, one or more rights to the real properties from the B and V sheets, and either no or more restrictions on the real property from the G sheet. One party may have zero or more property rights. According to the Law from 2009, a real estate folio contains a single real property with its rights and restrictions. This affects the previous model by changing the multiplicity on class RealProperty from 1..* to 1.

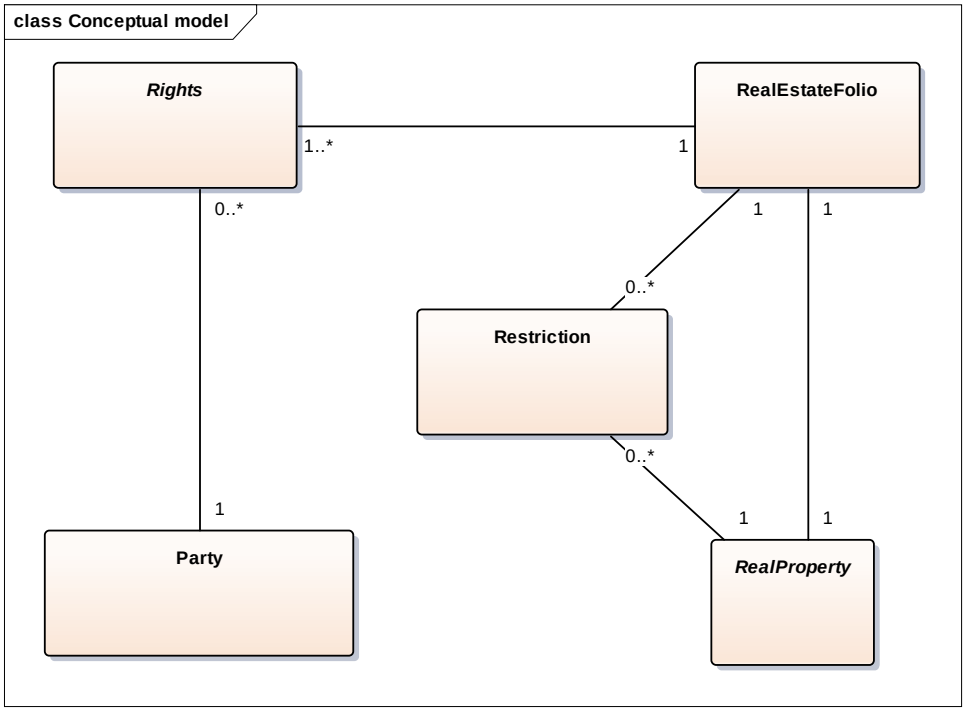

Figure 4. Conceptual cadastral model for Serbia

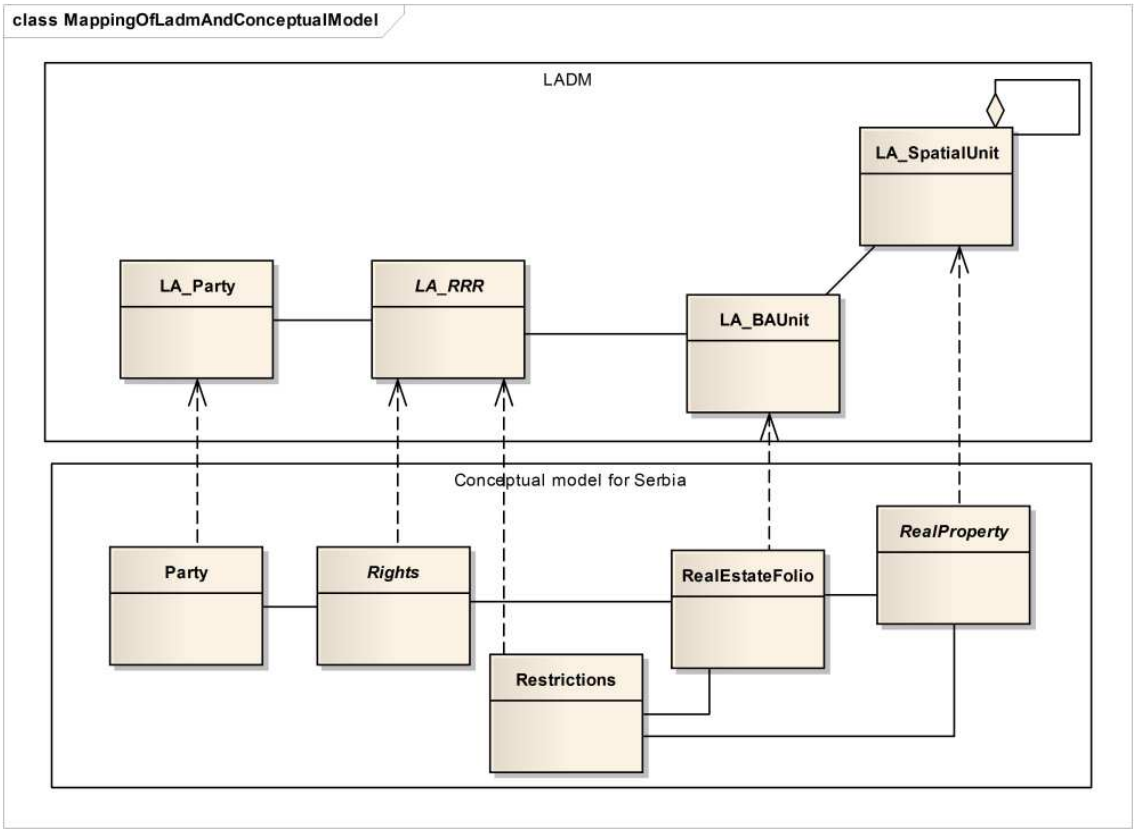

Figure 5. Mapping of LADM classes and classes from Serbian conceptual model

Next step was to analyze the possibilities of fitting the resulting conceptual model in LADM. Figure 5 (above) shows the mapping of LADM basic classes to Serbian conceptual model classes. The mapping was done similarly like in Montenegro.

Since the applicability of basic LADM on Serbian conceptual model is proven, it is possible to create corresponding basic classes of Serbian profile (Table 1). All classes from Serbian country profile have prefix RS. In Serbia real estate cadastre is fully established so it was not necessary to introduce a new code list for different registers like in previous two cases.

Table 1. Mapping of LADM classes and classes from Serbian, Montenegrin and Republika Srpska's profile

LADM class	Serbian profile class	Montenegrin profile class	Republika Srpska's profile class	CL
LA_Source	RS_Source	MNE_Source	BHRS_Source	1
Party package				
LA_Party	RS_Party	MNE_Owner	BHRS_Owner	1
LA_GroupParty	RS_GroupParty	MNE_GroupOwner	BHRS_GroupOwner	2
LA_PartyMember	RS_PartyMember	MNE_OwnerMember	BHRS_OwnerMember	2
Administrative Package				
LA_RRR	RS_RRR	MNE_RRR	BHRS_RRR	1
LA_Right	RS_Right	MNE_Ownership	BHRS_OwnershipParcel	1
LA_Right	RS_Right	MNE_Ownership	BHRS_OwnershipBuilding	1
LA_Restriction	RS_Restriction	MNE_Restriction	BHRS_Restriction	2
LA_Restriction	RS_Notice	-	-	2

LA_Restriction	RS_Easement	-	-	2
LA_Responsibility	-	-		-
LA_BAUnit	RS_BAUnit	MNE_RealestateFolio	BHRS_RealestateFolio	1
LA_Mortgage	RS_Mortgage	MNE_Restriction	BHRS_Restriction	2
LA_AdministrativeSource	RS_AdministrativeSource	MNE_AdministrativeSource	BHRS_AdministrativeSource	1
LA_RequredRelationshipBAUnit	RS_RequredRelationshipBAUnit	-	-	3
Spatial Unit Package				
LA_SpatialUnit	RS_SpatialUnit	MNE_SpatialUnit	BHRS _SpatialUnit	1
LA_SpatialUnit	RS_Parcel	MNE_Parcel	BHRS _Parcel	1
LA_SpatialUnit	RS_PartOfParcel	MNE_PartOfParcel	BHRS _PartOfParcel	1
LA_SpatialUnit	RS_Building	MNE_Building	BHRS _Building	1
LA_SpatialUnitGroup	RS_SpatialUnitGroup	MNE_CadastralMunicipality	BHRS _CadastralMunicipality	2
LA_SpatialUnitGroup	RS_SpatialUnitGroup	MNE_AdministrativeMunicipality	BHRS_AdministrativeMunicipality	2
LA_SpatialUnitGroup	RS_SpatialUnitGroup	MNE_City	BHRS_City	2
LA_SpatialUnitGroup	RS_SpatialUnitGroup	MNE_Country	BHRS_Country	2
LA_SpatialUnitGroup	RS_SpatialUnitGroup	MNE_CadastralDistrict	BHRS_CadastralDistrict	2
LA_LegalSpaceBuildingUnit	RS_LegalSpaceBuildingUnit	MNE_PartOfBuilding	BHRS_PartOfBuilding	3
LA_LegalSpaceUtilityNetwork	RS_LegalSpaceUtilityNetwork	MNE_LegalSpaceUtilityNetwork	BHRS_LegalSpaceUtility Network	3
LA_Level	RS_Level	MNE_Level	BHRS_Level	2
LA_RequredRelationshipSpatialUnit	RS_RequredRelationshipSpatialUnit	-	-	3
Surveying And Representations Subpackage				
LA_Point	RS_Point	MNE_Point	BHRS_Point	2
LA_Point	RS_Point	MNE_BasePoint	BHRS_BasePoint	2
LA_Point	RS_Point	MNE_DetailPoint	BHRS_DetailPoint	2
LA_SpatialSource	RS_SpatialSource	MNE_SpatialSource	BHRS_SpatialSource	2
LA_BoundaryFaceString	RS_BoundaryFaceString	MNE_PolyLine	BHRS_PolyLine	2
LA_BoundaryFaceString	RS_BoundaryFaceString	MNE_LineSegment	BHRS_LineSegment	2
LA_BoundaryFaceString	RS_BoundaryFaceString	MNE_Polygon	BHRS_Polygon	2
LA_BoundaryFace	-	-	-	-

2.4 Similarities and differences between profiles

The abstract test suite defined in Annex A of the ISO 19152 standard specifies the requirements that the development of country profile has to meet in order to be conformant to this standard. Three conformance levels are specified per (sub)package: level 1 (low level), level 2 (medium level), and level 3 (high level). Table 1 (below) shows the mapping of LADM classes, Serbian profile classes, Montenegrin profile classes and Republika Srpska's profile classes. A level of conformance to LADM is also shown (CL). All of three profiles are conformant to all classes from low and medium level and to several classes from high level of conformance.

Table 2. shows the similarities and differences between these three cadastral systems beside obvious differences on some attributes and code lists. First similarity is related on common terminology and use of document called real estate folio. The second criteria is based on the concept of real estate folio that is used in cadastre. There are two concepts „One to many" concept and „One to one" concept and relates on how many real properties are defined within real estate folio. First one is used in Republika Srpska and Montenegro and the other one is used in Serbia. Third criteria is related to whether the real estate cadastre is fully established or not. It is important fact since it affects data model. For example in Republika Srpska and Montenegro there are additional code lists that indicates whether real property is in real estate

cadastre or some other register. This also affects procedures and processes in information systems.

Table 2. Similarities and differences between three systems

Region	Real estate folio document	„One to many“ concept	„One to one“ concept	Real estate cadastre established	Migration
Serbia	yes	no	yes	yes	complex
Montenegro	yes	yes	no	not fully	easy
B&H Republika Srpska	yes	yes	no	not fully	easy

Last criteria indicates the level of complexity of migration of data from old data structure to new data model. This criteria is very important since it shows how much effort should be done to transit from old to new system. In Republika Srpska and Montenegro this step was easier since existing data model was relational and based on cadastral concepts. However, in Serbia data structures differ from municipality to municipality with a lack of relations between tables and they are based on outdated law, so the migration to new data model is very complex and must be iterative in order to resolve the inconsistency of the data as described by Sladić et al (2017).

3. LAND INFORMATION SYSTEM (LIS)

This section describes implementation of created profiles in practice in the form of a technical solution combining together software for maintaining cadastral and legal data (cadastral maps and data about rights), office management solution and development of on-line services for the citizens, to have an insight into their rights and restrictions.

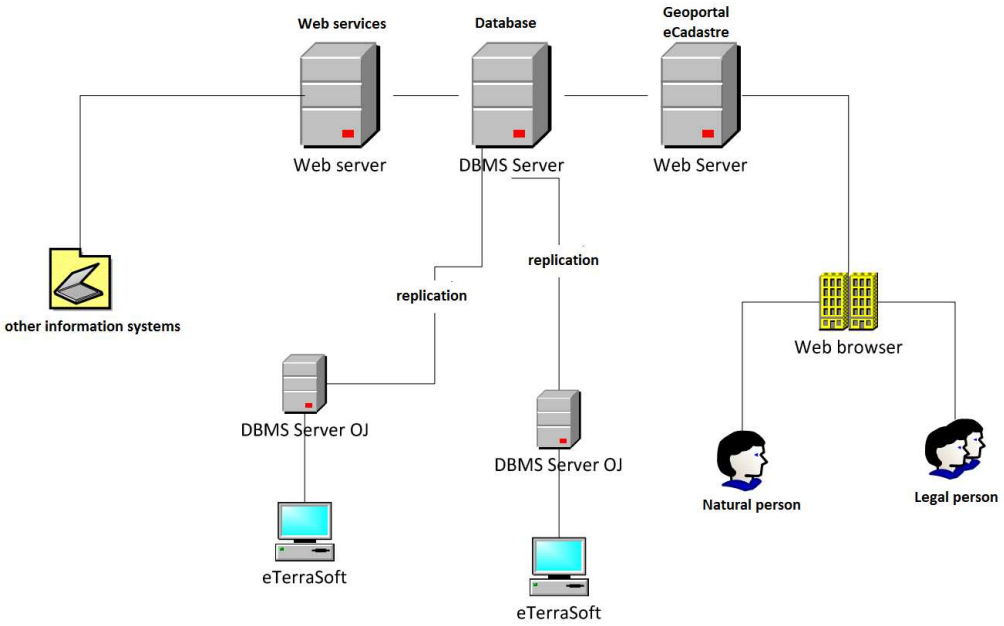

Figure 6. Architecture of land information system

There are three main subsystems of land information system in these regions: 1) land register containing alphanumeric data about land, buildings, rights and parties 2) cadastre containing spatial data about land parcels and buildings 3) office management for handling requests made by citizens. Software solution includes the functionalities for maintaining cadastral data by employees in mapping agencies and office management module which connects client requests for change of data or issuing the documents, with procedures in cadastre. Architecture of resulted land information system is shown on Figure 6 above.

Technical solution consists of several modules:

- module for maintaining cadastral data for employees in the geodetic authority. This module is in use in organizational units as part of Java desktop application. This module allows employees to change the spatial and graphical data on real properties (Pržulj et al, 2017) together with alphanumeric data like descriptive attributes or rights and restrictions in one transaction,
- module for maintaining office management data for employees in the geodetic authority. This module is in use in organizational units as part of Java desktop application. This module is connected with previous module which indicates that request from the external users and their subjects in office management are linked to transaction of changing the data in cadastral records,
- module for search and overview of cadastral data through web – eCadastre. This module is realized as web application which use both internal (employees) and external users (natural and legal persons),
- customized GIS tool for cadastral data for employees,
- Geoportal - for search and overview of geospatial data,
- Cadastral web services for integration with other information systems.

This technical solution provides users with unified code lists, maintained by year, status and activity, with automated processes and secure transactions, easy and fast access and search of data, as well as with automated reports for preventing abuse of data.

In the case of Republika Srpska all mentioned modules were implemented in practice except the cadastral web services. The challenges in implementation were to overcome the problems of old low-functional equipment and absence of good data center as well as data links, lack of necessary information from the geodetic authority etc. In the case of Montenegro, modules for maintaining cadastral (alphanumeric) data, office management module, eCadastre and customized GIS tool were implemented in practice. The challenges in implementation were based on previous bad cadastral procedures which resulted that real properties of half of the city were stored in one real estate folio. However, data center and cooperation with geodetic authority were good. In the case of Serbia office management module and cadastral web services for the eGovernment were implemented in practice. The challenges in Serbia: old equipment, data center exists but not functional for cadastral data since LIS application is DOS based, poor data links, lack of cooperation …

4. ELECTRONIC SERVICES FOR LIS

The purpose of electronic services is to provide access to these registers to the citizens which can be natural or legal persons. Part of that data is available to all, while more data is available to registered users which are usually legal persons involved in legal issues, such as notaries, banks, ministry of internal affairs, tax administration etc. There are three types of services that are in use: eCadastre service, Web services to support integration with information systems of cooperative organizations and geoportal services.

4.1 e-Cadastre

One of the main tasks the system has provided is online access to real-time data from real-time cadastral records via a web browser through the eCadastre web application. eCadastre enables internal and external users to view data in all municipalities. eCadastre service provides insight into land register and office management. Users are allowed to view data about rights over their properties. eCadastre enables users to view data about rights on real estates in a real estate folio on the basis of one of the search criteria. These search criteria include: the name or personal number of a person, the number of parcel, the number of real estate folio, etc. They can also view requests on properties and follow the execution of their requests. Issuing of documents and making request are provided for registered users. Particular attention is paid to notaries who, in addition to viewing the data, have the possibility to download electronically signed documents that are valid for further use. Also, notaries have the option of submitting requests for the implementation of changes in the cadastre and the possibility of monitoring the status of execution of their requests.
Services such as eCadastre enable public access to the cadastral data and make such data more transparent. Benefits of such services have been analyzed by Borzacchiello and Craglia (2013). This provides more security in real estate transactions and lowers the risk of fraudulent transactions which have been very common in the past years. This is a step forward to opening the government data to the public which has been very active in recent years through the development of e-Government in Serbia. However, it cannot be considered as Open Data, since only part of a dataset is available freely, and the data is not machine readable, nor downloadable. The implication of this is that data can not be easily used for research and analyses, for example.

4.2 Cadastral Web services

Cadastral Web services are intended for use by the information systems of other organizations (banks, Ministry of internal affairs, Ministry of finances - tax administration, business registry agencies, etc.) that use cadastral data, as well as for the work of the eGoverment portal through which online services to clients are executed.

In the case of Serbia, cadastral service SubmitRequest is developed as part of the service architecture necessary for the process of issuing documents through the eGovernment portal. Within this architecture several information systems are connected (Figure 7 below): eGovernment portal (*Portal eUprava*), land information system (*KAT*), information system of the Ministry of Finance Treasury Administration (*Trezor*), information system of the Ministry of internal affairs (*MUP*) and the information system of the Business Registers Agency (*APR*). These systems are connected via the eGateway subsystem of the land information

system which prepares the processing of electronic services. This subsystem is used as an access point for all participants (Radulović, 2015).

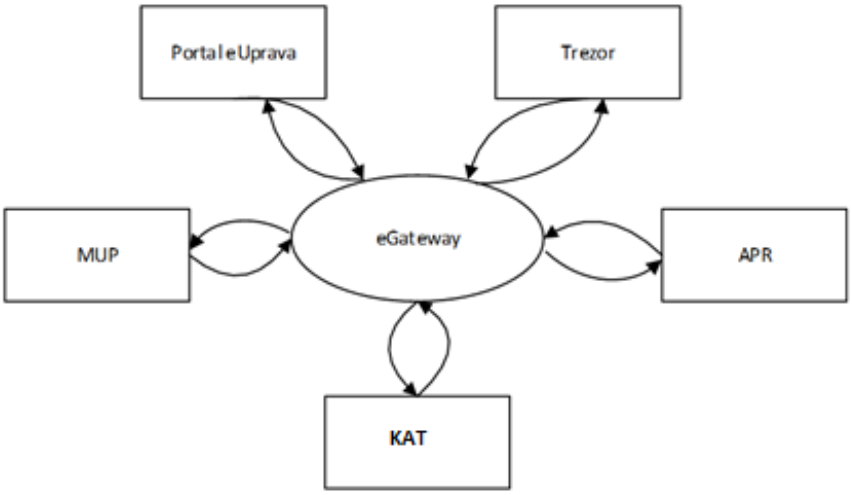

Figure 7. Communication of information systems in the process of issuing documents

The eGateway subsystem represents a technology platform that accepts an electronic request, analyzes it and sets the parameters for processing in land information system. Also, this subsystem enables secure communication of the land information system with the external systems. Communication with the portal is done by transferring documents or service parameters that are relevant in order to generate a guided service on the portal. Requests received from the eGovernment portal are forwarded to the land information system (*KAT*) which records parameters and process request. Land information system manages all service requests regardless of whether the request has arrived digitally or analogously. The eGateway subsystem provides secure communication with the Treasury Administration's information system so that authorized employees can have access to paid fees. eGateway establishes communication with information system of the Ministry of internal affairs and the information system of the Business Registers Agency in order to check the correctness of forwarded data.

In order to create needed service architecture, it is necessary to define the services for which the respective institutions are responsible and specify the messages exchanged between them. Based on this, it is possible to define a service choreography in the process of issuing documents through the eGovernment portal. The service choreography gives a description of how many participants interact with one another in achieving a goal. Choreography is used to understand and document the entire process at a higher level, and then use it when designing and implementing the services of each participant in choreography. The BPMN2.0 standard is used to describe business processes and to create a model for service choreography.

As previously mentioned, eGateway redirects messages from one institution to another and performs data checking. From the eGovernment portal, based on user requests, the eGateway's service *SubmitRequestG* is called, which checks the correctness of data on the

applicant by calling the service *CheckJMBG (MUP)* or *CheckMBR (APR)* service, depending on whether the applicant is a natural or legal person. Then, the *SubmitRequest* service of land information system (*KAT*) is called to verify the correctness of the request and record the request (Figure 8 below). In environment of actual land information system, certain activities of employess in the cadastre are necessary for the choreography to continue. In order to present these activities, user activities are introduced. After entering the request, the user verifies it and calls the eGateway's service *GetStatementG*, and eGateway calls the Treasury's *GetStatement* service to check if the fees are paid. When the employee receives information that the payment is done, the payment is recorded in land information system and the subject of the office management is formed. This action calls the eGateway's service *GetStatusChangedG*, which calls the eGovernment's service *GetStatusChanged* to inform the applicant about the progress in his request. Further, the employee creates a document and calls the eGateway's service *DocumentUploadG*, which calls the eGovernment's service *DocumentUpload* service that send the digitally signed document to the applicant.

In the case of Montenegro web services are implemented to provide cadastral services to other information systems such as the Ministry of internal affairs, the Commission for the Prevention of Conflict of Interest, banks, insurance companies, the Ministry of Agriculture and Rural Development, the Ministry of Labor and Social Welfare, local self-government ... Web services are described with WSDL specification, and message exchange is done via the SOAP protocol. Developed services for other information systems are:

- *Opstine* - returns the list of administrative municipalities and unique identifiers of municipalities;
- *Katopst* - returns a list of cadastral municipalities and unique identifiers of cadastral municipalities;
- *ListKz* - for a certain cadastral municipality and one of the parameters (land folio number or parcel number) returns data on land folio (data on parcels, rights on parcels, restrictions);
- *ListKn* content - for a certain cadastral municipality and one of the parameters (real estate folio number, parcel number, building number, part of building number) returns the contents of the real estate folio (data on parcels, rights on parcels, data about buildings and parts of buildings and rights on them and restrictions);
- *ListLica* - returns data on land and real estate folios for the particular person (natural or legal);
- *NepoLica* - returns data on land and real estate folios together with their contets (parcels, building, part of buildigns, rights, restrictios) for the particular person (natural or legal).

A service *signPDF* is used for digital signing of documents that are downloaded by notaries through eCadastre. A digital signed document is valid for further use in the activities of notaries and other users to whom this option is available.

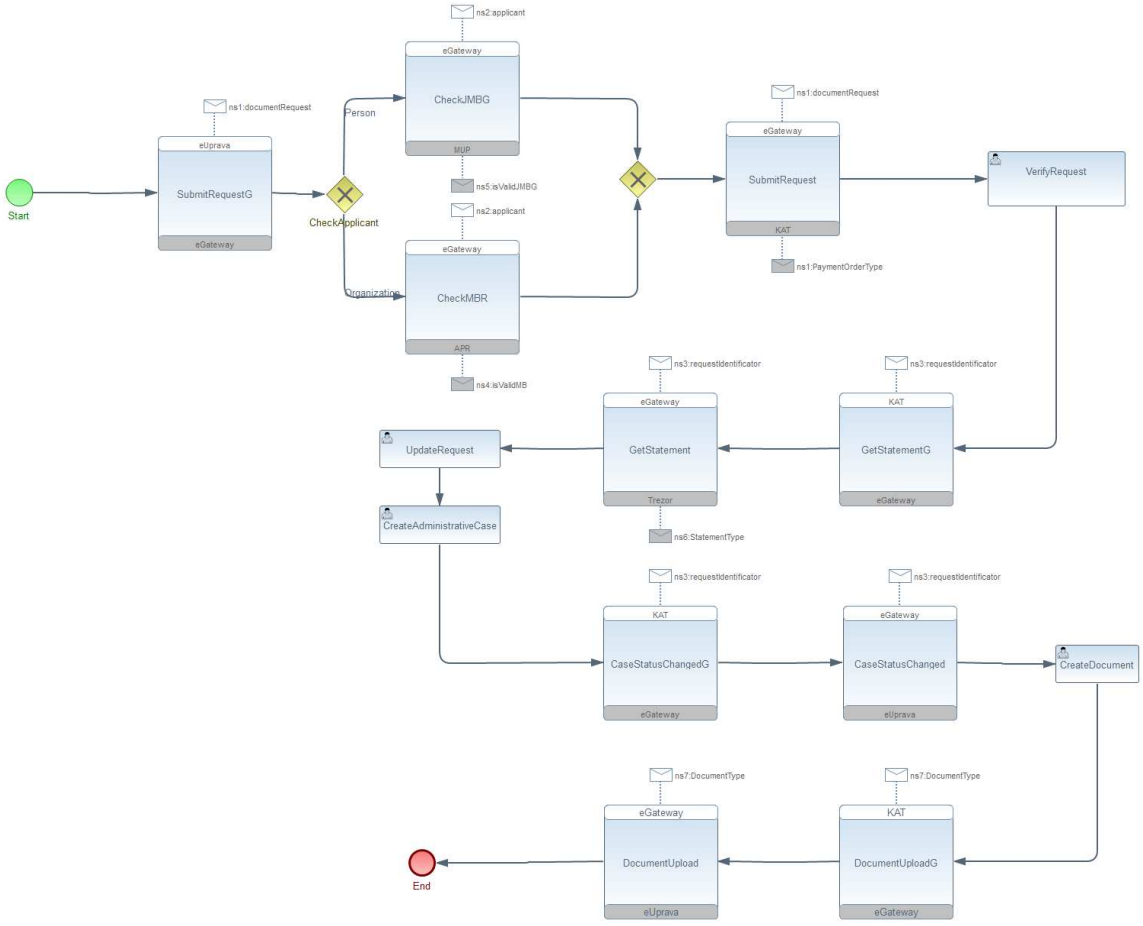

Figure 8. Service choreography

4.3 Geoportal

Geoportal is established and maintained by the mapping agencies as part of the Spatial Data Infrastructure and provides view of layers of spatial data, including parcels and buildings (Jovanović et al, 2012). Although data is published as WMS and WFS, only registered users can download data for a certain fee, therefore data is not open for general public, which is the case in some countries (e.g. Czech Republic). This would allow easier research, spatial analyses, the use in education process, etc. Even the procedures to obtain data for a fee are not fully implemented, and in the case of Serbia, getting cadastral data is not a trivial task.

5. DISSCUSSION ON 3D FOR LIS

This Section presents a review of current technologies for 3D data acquisition and formats that could be used in the cadastre. Technology is progressing and there is a growing need for 3D datasets. 3D models provide realistic visualization of spatial infrastructure. 2D and CAD formats can no longer provide the required amount of information whether it is a question of a real estate cadastre or a utility network cadastre. This is one of the reasons why 3D formats are becoming more and more important The most commonly used technology for data acquisition is a laser scanner, Global Position System (GPS), ground penetrating radar (GPR), etc. Laser scanner is very often used when there is a need for 3D models, especially when it is integrated in LIDAR system. It is used for 3D data acquisition of powerlines, railways, and other infrastructures (Popović et al, 2017a). The GPR is used to collect information on underground infrastructure such as gas pipelines or other kind of utility network (Ristić et al, 2017). This data can be used as input into utility network cadaster, and can also produce 2D and 3D data. The process of creation of 3D models of buildings in CityGML format using LIDAR data has been described by Popović et al (2017b). An example of 3D building model in the CityGML format created from LIDAR data using this procedure has been shown on Figure 9. This 3D model can be used to expand the cadastre with the 3D, by linking LADM profiles and CityGML data model and mapping legal spaces in CityGML model. The integration of LADM with CityGML for the purpose of 3D cadastre has been proposed by Rönsdorff et al (2014) and Gózdz et al (2014). Also, using BIM IFC as a source for 3D legal spaces has been proposed by Oldfield at al, 2017.

Figure 9. CityGML model of Faculty of Philosophy, University of Novi Sad

Utility infrastructure is also important part of LIS. Figure 10a below) shows a possible 3D model that can be implemented in the concept of a utility network. Data was collected by GPR and further processed to achieve the shown model. Figure 10b below) shows powerlines obtained by processing LIDAR data, for the purpose of legalization procedures using utility network cadastre (Popović et al, 2017a).

In surveying and engineering practice in this region, spatial data is mostly in CAD format, while BIM is not in such a wide use, mainly because of lack of qualified staff in BIM modeling, and also the habit from the past to use CAD drawings (Đurović et al, 2009).

Despite that, if proved useful, mapping agencies together with private sector, may do more to promote the use of BIM in engineering design.

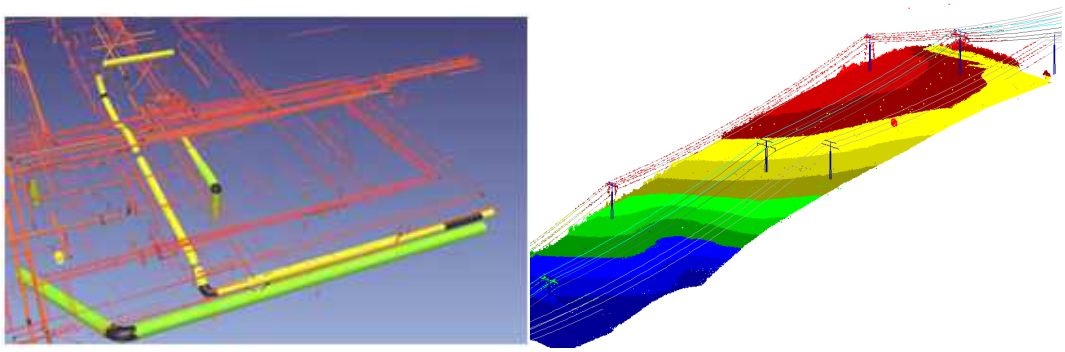

Figure 10. 3D mapping of utility infrastructure a) underground pipeline b) powerlines

6. CONCLUSION

The paper presents the development of LADM based profiles for Serbia, Montenegro and Republika Srpska. It is shown that all of three profiles are conformant to all classes from low and medium level and to several classes from high level of conformance. It is shown how land information systems in these countries and regions are organized as well as similarities and differences between three systems. Implementation and challenges in these systems has been presented. Considering the fact that the technologies for 3D data acquisition are getting more and more users in these countries, and the production of 3D data is increasing, this input can be used for registering 3D legal space in cadastre. Future work will include research on procedures how to develop 3D legal space by linking CityGML or BIM to LADM profiles.

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