

# The land administration domain model (LADM) as the reference model for the Cyprus land information system (CLIS)

E. A. Elia\*<sup>1</sup>, J. A. Zevenbergen<sup>2</sup>, C. H. J. Lemmen<sup>2</sup> and P. J. M. van Oosterom<sup>3</sup>

In this paper, the enhancement of the data model of the Cyprus land information system (CLIS), with the adoption of the land administration domain model (LADM) is examined. The CLIS was established in 1999, within the Department of Lands and Surveys, to support the operation of the Cyprus cadastral system and has met the majority of its initial set goals. It is however now broadly accepted that the CLIS should be improved and upgraded, and a new data model should be introduced to facilitate the manipulation and provision of data to internal and external users/customers in a more effective way. The need to enhance the CLIS coincides with the introduction of the LADM, which is under development within the Technical Committee 211 of the International Organization for Standardization and identified as ISO 19152. The LADM provides an abstract, conceptual schema with three basic packages: parties (such as people and organisations), administrative rights, responsibilities and restrictions (such as property rights) and spatial units (such as parcels, buildings and networks), with the latter having one subpackage: surveying and spatial representation [6]. [Note: In this moment (January 2012), the LADM is at the development stage of Final Draft International Standard]. In this paper, the basic entities of the CLIS are presented and restructured, in a way to comply with the LADM. After analysing the characteristics of LADM, it is concluded that this is compatible with CLIS, and can be used as a data model framework for CLIS's upgrade. Thus, the Cyprus country profile is proposed. The adoption of the LADM is a great opportunity for the Department of Lands and Surveys to introduce an International Organization for Standardization standard model, based on model driven architecture, and to gain all the benefits derived from such a movement. Such benefits include the improvement in the effectiveness and the efficiency of the current system and the expansion of the services provided by CLIS to the broader land administration system and to the Cyprus community. The new functionality includes: better structuring of the rights, responsibilities and restrictions (and related source documents); better fitting in the information infrastructure, both national (e.g. valuation, taxation, building, address and person registrations) and international (e.g. INSPIRE cadastral parcels); and future capabilities for representing three-dimensional spatial units (e.g. legal spaces related to apartment or utility infrastructure).

**Keywords:** Cyprus land information system (CLIS), Land administration domain model (LADM), Cyprus Department of Lands and Surveys (DLS)

## Introduction

Cyprus has a reliable cadastral system supporting the administration of land and other immovable property-related

activities. The authority responsible for the operation of the cadastre is the Department of Lands and Surveys (DLS). In 1999, the Department established a land information system [Cyprus land information system (CLIS)] to support its survey and mapping, registration of rights, responsibilities and restrictions (legal security), valuation, and management functions, with the upper objective of developing/upgrading it into a national land information system (NLIS).

The current CLIS, as deployed within DLS, has met the majority of its intended business goals. However, it is

<sup>1</sup>Department of Land and Surveys, 1455 Nicosia, Cyprus

<sup>2</sup>Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Hengelosestraat 99, 7514 AE Enschede, The Netherlands

<sup>3</sup>Research Institute for the Built Environment (OTB), Delft University of Technology, Jaffalaan 9, 2628BX Delft, The Netherlands

\*Corresponding author, email [elikkoselia@gmail.com](mailto:elikkoselia@gmail.com)

now recognised that the current solution and its underlying architecture is at the end of its life cycle, and is no longer a suitable programming framework or a suitable technology foundation for meeting the developing needs of DLS. Furthermore, the current system cannot meet all the requirements for the implementation of an NLIS. There is a need to introduce a new data model facilitating the provision of data to internal and external users/customers in a timelier manner and in a more flexible format. The data model could be normalised to eliminate data duplication and to improve the quality of cleanliness of the data.

The need of introducing a new data model for the CLIS coincides with the development of the land administration domain model (LADM). The LADM is under development within the Technical Committee 211 (TC211) of the International Organization for Standardization (ISO) [5] and identified as ISO 19152. The model provides an abstract, conceptual schema with three basic packages related to: parties (such as people and organisations), rights, responsibilities and restrictions (property rights) and spatial units (such as parcels, buildings and networks), with the latter having one subpackage: surveying and spatial representation [6]. The concept of LADM, its content and the proposed packages, seem, from an initial look, to suit the needs for the enhancement of CLIS.

In this paper, the relation of CLIS data model and LADM is examined, and the migration of CLIS basic entities to LADM classes is proposed. The paper is structured as follows. A short introduction to the CLIS is given, and a brief description of the current data model of CLIS is made. Then the LADM, based on the current version in ISO Draft International Standard DIS 19152 [8], [4], [6], is introduced. The need for restructuring the CLIS's data model is discussed and the country profile, based on LADM, is proposed. Instance level diagrams for various cases are presented as examples. Finally, conclusions are discussed about the need to redefine the Cyprus data model, in order to comply with the LADM, and also directions for future work/research are given.

## The CLIS

Cyprus has a sound cadastral system supporting the administration of land and other immovable property-related activities. The authority responsible for the operation of land registration is the DLS, which is the oldest department in the government service, dating back to 1858. The initial and main responsibility of DLS is the registration of immovable property on the island. The registration is based on cadastral plans, which are linked to the national grid and cover the whole island. All parcels, including state land, appear on the register and on plans. The cadastral plans are prepared and updated by the state. The boundary points are not necessarily marked on the ground.

The system of land registration is that of title. A registered person is considered to be the undisputed owner and his/her title to ownership is absolute, subject to the Lands and Surveys Department Director's power to correct errors or omissions, and to the inherent power of the Courts to order an amendment. In Cyprus, no transfer of, or change on any right on an immovable property is valid, unless registered in the DLS. Title is

not guaranteed by the State and there is no indemnity fund; but the whole system is highly trusted by the public.

Over the years, the DLS expanded its activities and services offered to the public, emerging as a dynamic organisation, supporting a multipurpose cadastre. Its activities include the maintenance of the state survey infrastructure; the definition, identification, demarcation, measuring and mapping of parcel boundaries; the investigation of title; the registration, conveyance, valuation, compulsory acquisition, requisitions and imposition of encumbrances. Furthermore, DLS is responsible for the conservation and management of state land and acts as the National Mapping Agent of Cyprus. The cadastre system in Cyprus plays a fundamental role in broader land administration activities. Through the computerisation of spatial and textual data, the cadastre now serves a multipurpose role supporting many activities. These include supporting the registration of rights, responsibilities and restrictions (legal security), land management and planning, land development, local government and utilities management and many other functions.

In 1989, a strategic plan was introduced by DLS with two major objectives: the establishment of a fixed boundary coordinated cadastral system, through a major resurvey project; and the development of a land information system (CLIS), to support the survey, mapping, registration, valuation and management functions of the DLS with a strategy to implement a NLIS.

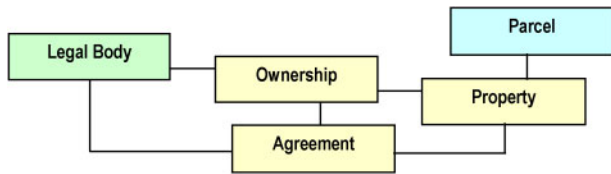
The CLIS officially started in September of 1995 and consisted of five phases: user requirements, system design, system development, testing and implementation. The system was deployed in 1999 and was completed in April 2001. The CLIS has been designed and developed having two major application components: the legal/fiscal applications (legal/fiscal component), which cover all business functions related to the registration of immovable properties, transfers, inheritances, mortgages, tenure, compulsory acquisitions, requisitions, property and personal encumbrances, easements, contracts of sales, forced sales, properties valuation, etc. and the survey related applications (geometric component), which maintain and update two seamless datasets, namely digital cadastral database and survey database with information related to the identification, shape, location of land parcels, topographical features and generally all features related to the cadastral map.

## The data model of the CLIS

In the CLIS, all data related to properties, ownerships and owners (legal bodies), attachments and valuation data, are stored in the property database. The property database is a mirror of the contents of land register pages, contains all the necessary information required to issue a legal title certificate of ownership and reflects information on potential impediments. The property identification or the owner identification is the main entry point to the property database. Data stored in the property database can either be provisionally registered or fully registered. Fully registered data make up the bulk of the property database [1].

### Ownership

The ownership relation is used to record the owners of all properties recorded in the system. Ownerships are



1 CLIS basic entities

recorded as fractions, as more than one owner may be recorded for a property. The sum of the fractions for each property should be the equivalent of 1:1 (which means 100%) at any point in time, i.e. no fraction must be unrelated/non-existing.

Agreement (contractual arrangements)

Various restrictions (charges) may be recorded regarding properties, ownership and/or legal bodies. These are given the common name ‘agreements’. The existing categories of such contractual arrangements include property or personal easements, interests, restrictions, mortgages, contracts of sale, encumbrances and prohibitions. An example is when someone has bought an apartment which is still under construction. The apartment, because it is under construction cannot be registered in DLS. For this reason, and to secure the purchase, the contract of sale is recorded at DLS as a restriction on the parcel (lot). With this restriction, the developer could not sell the lot or the apartment under construction to somebody else, without approval of the purchaser. After the completion of the building, the apartment and its owner are registered and the title certificate is given. The contract of sale restriction is cancelled.

Legal body

The primary purpose of the ‘legal body’ within the CLIS is to serve as an identification of owners of immovable property, but also as an identification of other legal bodies used in the system as lawyers, mortgagees, employees, etc. The legal body is divided into two main groups: persons and organisations. This division is selected because the characteristics of each group are different. These two groups are further subdivided into ‘persons’, ‘foreigners and other persons’, ‘companies’, ‘cooperatives’ and ‘other organisations’.

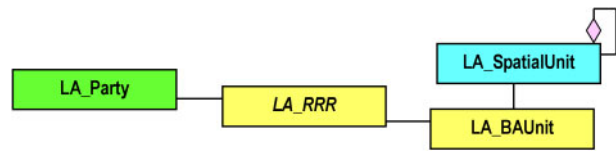
Property

The property is the central entity in the CLIS, as it contains an identification of all immovable properties in Cyprus. The property identification is used to record the ownership or lease of a property and also can be used as a recording of the persons liable to pay property tax. The ‘property’ entity does not hold much information in itself, but can be considered as an umbrella for a more detailed description of the property. The information that must always be recorded for a registered property can be summarised as:

- (i) ownership
- (ii) at least one subproperty, e.g. parcel or unit
- (iii) the parcel on which the property is located (Fig. 1).

LADM

The LADM [4], [6], [8] is under development within the TC211 of the ISO (ISO/TC211, 2010) and identified as



2 Basic classes of LADM [6]

ISO 19152. The model provides an abstract, conceptual schema with three basic packages related to: parties (such as people and organisations), rights, responsibilities and restrictions (property rights) and spatial units (such as parcels, buildings and networks), with the later having one subpackage: surveying and spatial representation [6] (Fig. 2).

The LADM provides a reference model which will serve two goals: to provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on model driven architecture (MDA), and to enable involved parties, both within one country and between different countries, to communicate, based on the shared vocabulary (i.e. an ontology) implied by the model. The second goal is relevant for creating standardised information services in an international context, where the land administration domain semantics have to be shared between regions, or countries, in order to enable necessary translations [4].

The three main packages of the LADM, the party package, the administrative package, and the spatial unit package are presented below.

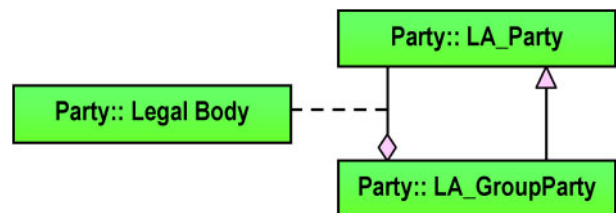
Party package

The main class of this package is class LA\_Party (with ‘party’ as an instance), and with its specialisation LA\_GroupParty (with ‘group party’ as an instance). There is an optional association class LA\_PartyMember (Fig. 3). Parties are persons, or groups of persons, or juridical persons, that compose an identifiable single (legal) entity. A juridical person may be a company, a municipality, the state or a church community. The definition of ‘party’ implies that a party may be a natural person, or a group of natural persons, or a non-natural person. A ‘group party’ is any number of parties, forming together a distinct entity. A ‘party member’ is a constituent of a party or group party.

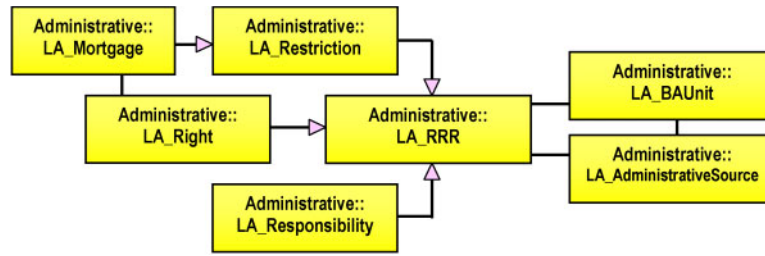
Administrative package

This package concerns the abstract class LA\_RRR (with its three concrete subclasses LA\_Right, LA\_Restriction and LA\_Responsibility), and class LA\_BAUnit (with ‘basic administrative units’ as instances) (Fig. 4).

A ‘right’ is a formal or informal entitlement to own, to do something, or to refrain from doing something. Examples are: ownership right, tenancy right, possession, customary right or informal right. A right can be



3 LADM party package classes [6], [8]



4 LADM administrative package classes [6], [8]

an (informal) use right. Rights may be overlapping, or may be in disagreement.

A ‘restriction’ is a formal or informal entitlement to refrain from doing something, e.g. it is not allowed to build within 200 m of a fuel station, or, a servitude or mortgage as a restriction to the ownership right.

A ‘responsibility’ is a formal or informal obligation to do something, e.g. the responsibility to clean a ditch, to keep a snow-free pavement, or to remove icicles from the roof during winter, or to maintain a monument.

A ‘baunit’ (an abbreviation for ‘basic administrative unit’) is an administrative entity consisting of zero or more spatial units (parcels) against which (one or more) rights (e.g. an ownership right or a land use right), responsibilities or restrictions are associated, as included in a land administration (LA) system. An example of a ‘baunit’ is a basic property unit with two spatial units (e.g. an apartment and a garage).

It should be observed in relation to this that rights, restrictions and responsibilities (RRR) may affect only a part of the spatial unit, with the geometric representation of that part missing. A ‘basic administrative unit’ may be a ‘party’, because it may hold a right of easement over another, usually neighbouring, spatial unit.

Spatial unit package

This package concerns the classes LA\_SpatialUnit, LA\_SpatialUnitGroup, LA\_Level, LA\_LegalSpaceNetwork, LA\_LegalSpaceBuildingUnit and LA\_RequiredRelationshipSpatialUnit (Fig. 5).

A ‘spatial unit’ can be represented as a point (or multi-point), a line (or multi-line), representing a single area (or multiple areas) of land (or water) or more specifically, a single volume of space (or multiple volumes of space). Single areas are the general case and multiple areas the exception. Spatial units are structured in a way to support the creation and management of basic administrative units.

Spatial units are a flexible concept of representing reality, e.g. spatial units may be described: in text (‘from this tree to that river’), or based on a single interior point, or as a collection of lines, or as a polygon, or as a

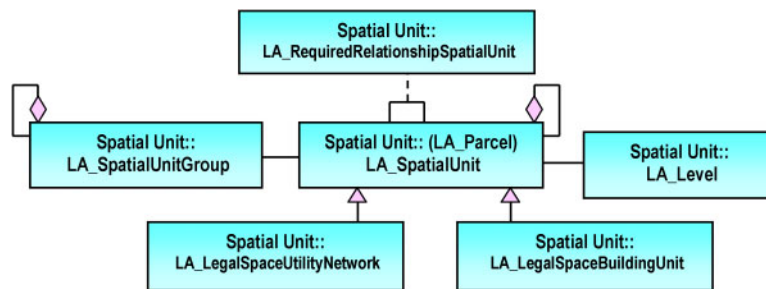
three-dimensional (3D) volume. A ‘spatial unit group’ is a group of spatial units, e.g. spatial units within an administrative zone (e.g. a section, a canton, a municipality, a department, a province or a country), or within a planning area [9].

A ‘level’ is a collection of spatial units with a geometric or thematic coherence. To implement the ‘principle of legal independence’, as introduced in ‘Cadastré 2014’ [7], it is necessary to investigate the laws in a jurisdiction and to identify those laws with an effect on land. The different spatial units may be arranged to ‘information levels’ according to the laws by which they are defined.

The spatial unit package has one surveying and spatial representation subpackage, with classes such as LA\_SpatialSource, LA\_Point, LA\_BoundaryFaceString and LA\_BoundaryFace (Fig. 6). Points can be acquired in the field by classical surveys, or with images. A survey is documented with spatial sources. A set of measurements with observations (distances, bearings, etc.) of points, is an attribute of LA\_SpatialSource. The individual points are instances of class LA\_Point, which is associated with LA\_SpatialSource. Two-dimensional (2D) and 3D representations of spatial units use boundary face strings (2D boundaries implying vertical faces forming part of the outside of a spatial unit) and boundary faces (faces used in 3D representation of a boundary of a spatial unit). Coordinates themselves either come from points, or are captured as linear geometry. Spatial units may share the same representation structure: existing 2D data, whether topologically structured or not, or polygons, or unstructured boundaries, or simply point or textual descriptions, can be included.

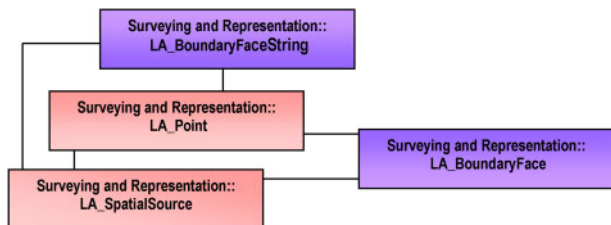
The Cyprus country profile, based on LADM

The current CLIS, as deployed within the DLS, supports the operation of the Cyprus cadastre and the land administration system. However, DLS now recognises that the current solution and its underlying architecture is at the end of its life cycle and is no longer a suitable



5 LADM spatial unit package classes [6], [8]





6 LADM surveying and representation subpackage classes [6], [8]

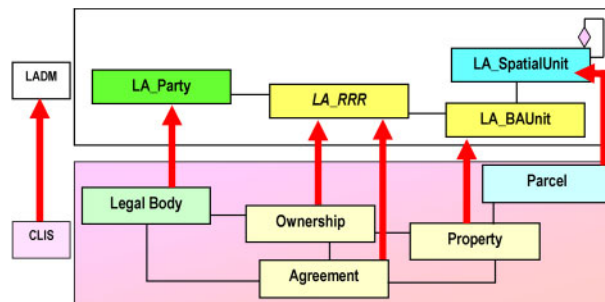
programming framework or a suitable technology foundation for meeting the developing needs of the Department. A main concern of CLIS is the future support for its operating system and database software. The current system uses Solaris 8 as operating system, Oracle Forms 6i and Workstation ArcInfo 8.3, which are at the end of their technological life. The system is at a point where it is difficult to migrate to newer technologies, as it is one or two generations behind on the technology curve. Furthermore, it cannot meet the requirements for the implementation of an NLIS, especially the ‘interoperability’ requirement, where diverse geographic systems, in various organisations/departments, can work together.

There is a need to start planning for the future and chart a course for redefining the data model of CLIS and updating/replacing components of the system. A new data model could facilitate the provision of data to internal and external users/customers in a timelier manner and in a format more flexible to the community’s needs. There is a need to reengineer business processes to simplify procedures and the number of steps to complete a transaction-process. The data model could be normalised to reduce data duplication and to improve data integrity.

Standardisation has become a well-known process in the work of land administrations and land registries. In both paper-based systems and computerised systems, standards are required to identify objects, transactions, relationships between objects (e.g. parcels, more generally spatial units) and persons (e.g. citizens, or subjects legally speaking, and more generally speaking parties), classification of land use, land value, map representations of objects, and so on. Computerised systems require further standardisation, when topology and the identification of single boundaries are introduced. In existing land administrations and land registries, standardisation is generally limited to the region, or jurisdiction, where the land administration (including cadastre and/or land registry) is in operation. Open markets, globalisation, and effective and efficient development and maintenance of flexible (generic) systems require further standardisation [4].

In this paper, the Cyprus country profile with its core classes is presented, based on LADM. The LADM is being studied and country profiles based on it have been prepared for a number of countries (Iceland, Canada, Czech Republic, Portugal, Queensland/Australia, Russian Federation, South Korea, the Netherlands, Hungary, Japan and Indonesia), as a result of academic research or other work [5], [8], [4], [3].

As it is shown in Fig. 1, the CLIS focusses on the ‘ownership’ right. Other RRR are also recorded, mainly as ‘agreements’ (contractual arrangements), but, in some



7 ‘Migration’ of CLIS entities to LADM classes

cases, not in a structured format. The harmonisation with the LADM will cope with this issue. Furthermore, the current CLIS application does not handle efficiently the legal documents, which are circulated and stored in paper form. The ‘administrative source’ class of LADM also resolves this problem and indicates the way of handling the legal paper documents, required for the operation of the Cyprus land administration system.

An enhancement of the existing CLIS model to comply with the LADM requires the ‘migration’ of CLIS entities to LADM classes. A detail examination of these entities/classes indicated that there is a direct relation between them, and the proposed migration is shown in Fig. 7 [2].

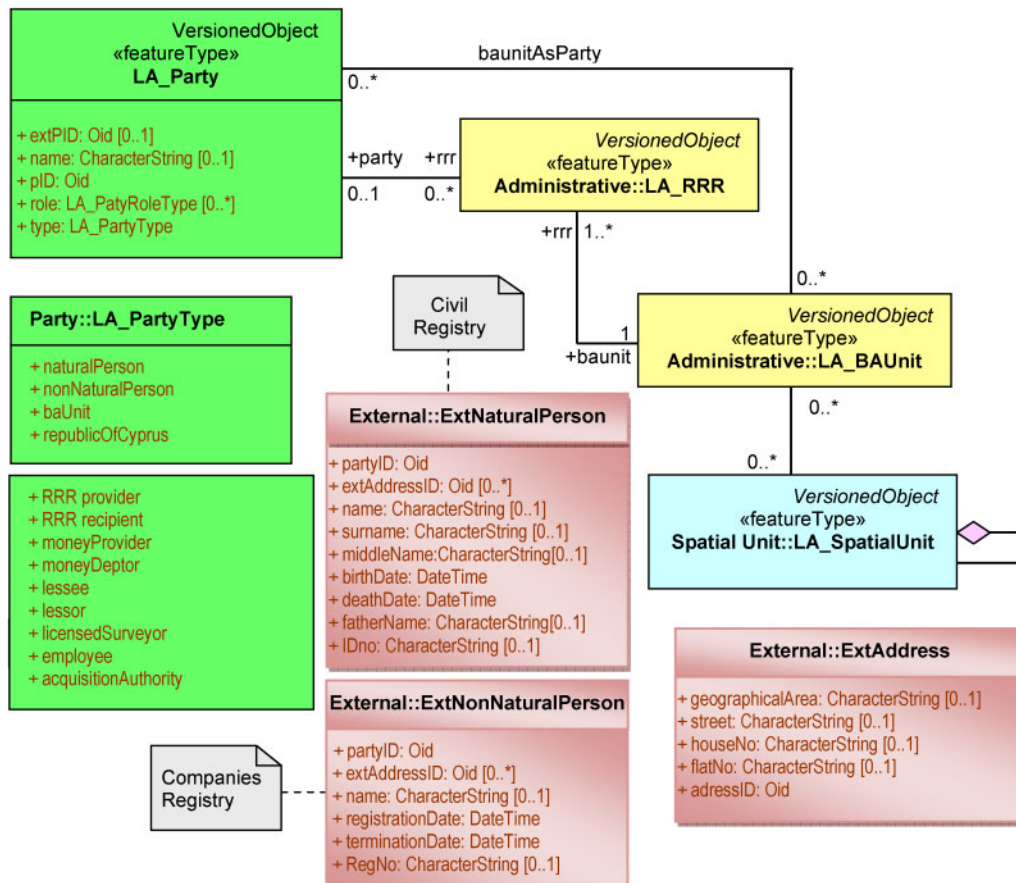
**CY\_Legal Body→LA\_Party**

The ‘legal body’ entity should be converted to ‘LA\_Party’ class. The ‘LA\_Party’ could host all types of legal bodies stored in CLIS. Figure 8 shows the content of the party class and associations with other basic classes, in the proposed CLIS data model, based on LADM. Examples of party types include natural persons contained in the external class of the civil registry, and non-natural persons, such as companies contained in the external class of the companies registry. The role of a party is activated in the data update and maintenance process.

**CY\_Ownership→LA\_RRR, CY\_Agreement→LA\_RRR, CY\_Property→LA\_BAUnit**

In CLIS, the ‘ownership’ right is handled as a separate entity, while other RRR are recorded as ‘agreement’ (contractual arrangements) entities. The ‘ownership’ entity could constitute a type of ‘LA\_Right’ class and along with the ‘agreements’ should be migrated into LA\_RRR classes, as a result of an upgrade of the CLIS and a restructuring of its data model. All ‘agreements’, registered in CLIS, could be types of ‘LA\_Rights’ or ‘LA\_Restrictions’. The ‘administrative source’ class of LADM is expected to solve the problem of handling the huge amount of legal paper documents, required for the operation of the Cyprus land administration system. Paper documents should be converted in electronic form for easy accessing, sharing and archiving. The ‘property’ entity should be converted to ‘LA\_BAUnit’ class (Fig. 9).

Each jurisdiction has a different ‘land tenure system’, reflecting the social relationships regarding RRR as regards land in that area. The variety of rights is quite large within most jurisdictions, and the exact meaning of similar rights may differ considerably between jurisdictions [4]. In the existing Cyprus cadastral system, a large number of RRR are registered or recorded, creating a multi-purpose cadastre. The recording of RRR, however,



**8 Content of the party class in the proposed CLIS data model, based on LADM**

is, in some cases, ‘unstructured’. A major advantage in adopting LADM is the classification and structuring of RRR. The RRR should be classified and separated in various categories (Fig. 10).

The rights are classified to:

- (i) rights related to ownership, which include the right of ownership, disputed ownership, illegal possession and adverse possession
- (ii) easements and other rights attached to parcels units. They are real rights, meaning that the rights remain valid even when the ownership of the unit is transferred from one party to another and include the passage right, the channel access, the storey erect and the exclusive use right
- (iii) easements and other rights attached to parties. Personal easements are rights which as long as they are valid, the consent of the beneficiary party is required for the transferring of the ownership right and for other property related transactions. These rights include usufruct, residence right, income, use, channel access for party. The custody is also a right attached to a party
- (iv) finally the lease right, which, according to the purpose for which the lease is conducted can be agriculture, industrial, farming, touristy, mining, forest, sports, communal, utility or special agreement lease.

The restrictions are classified to:

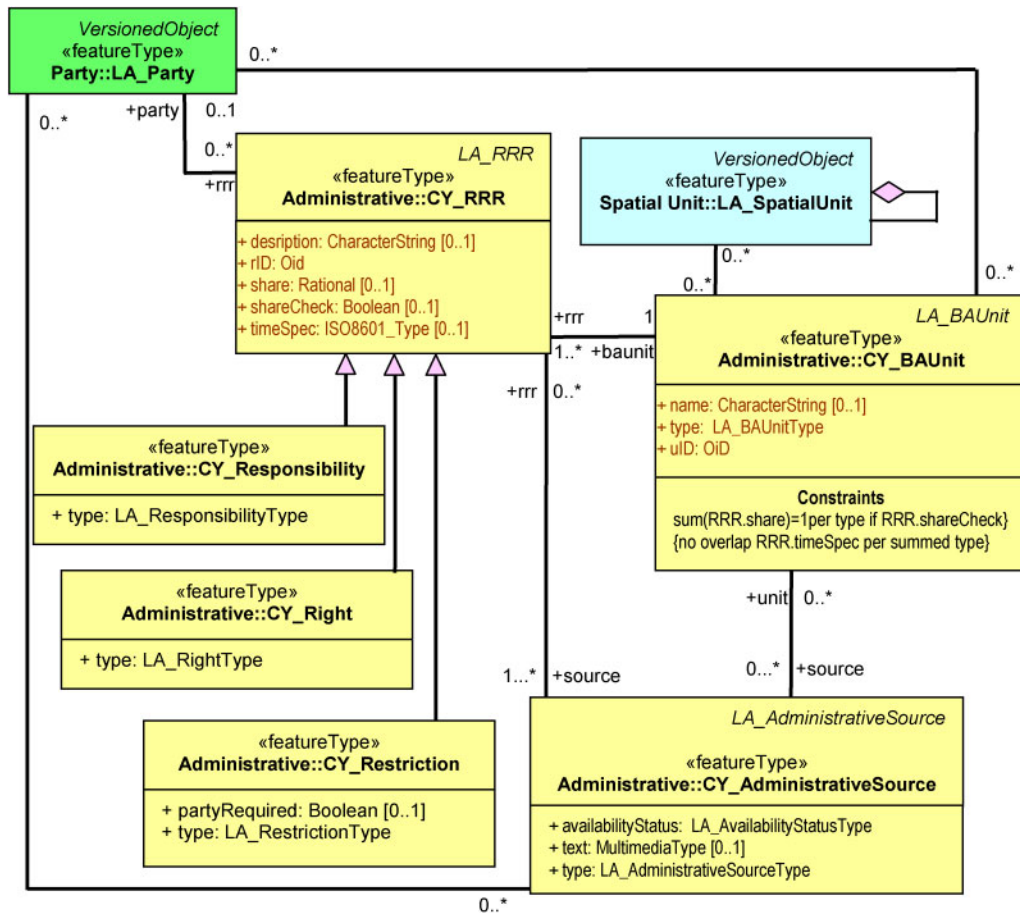
- (i) restrictions attached to parcel units, as encumbrances. An encumbrance is a direct restriction

(charge) upon an immovable property. It may be a voluntary charge (e.g. mortgage and contract of sale) or a result of court order [e.g. registration of judgment and writ of sale (contract)]

- (ii) restrictions attached to parties (prohibitions) which constitute an indirect restriction (charge) upon immovable property, resulting in the forbidding, prevention or interdiction of any person (party) from transferring or mortgaging all or any of his/her immovable property under the provisions of any law in force for the time being. The basic restrictions attached to parties, in the Cyprus land administration system, include the interim order, the court administration appointment and the bankrupt. In the Cyprus land administration system, there are various responsibilities on parties related to spatial units. These responsibilities (obligations to do something) are enforced by different legislations, by the government, local authorities or other organisations. Examples of responsibilities enforced by DLS include the responsibility of property owners to pay the annual immovable property tax and in the cases of leases of state land, the tenant has a responsibility to pay the annual rent.

**CY\_Parcel→LA\_SpatialUnit**

The ‘parcel’ entity should be converted to ‘LA\_SpatialUnit’. The LADM supports the increasing use of 3D representations of spatial units, without putting an additional burden on the existing 2D representations [4]. The CLIS supports only 2D representations. There



9 Content of administrative classes and associations with other basic classes, in the proposed CLIS data model, based on LADM

is, however, an increasing interest on 3D representations [10] and DLS could consider moving to a 3D cadastre; this will be supported by the LADM country profile.

Figure 11 illustrates the spatial unit class in the proposed CLIS data model, based on LADM. For the time being, a 2D representation of spatial units is used, which could be extended to 3D in the future. The LA\_SpatialUnitGroup can be used to define the level in the hierarchy of administrative subdivisions as well as for planning zoning. Cyprus is divided in districts, quarters and parcel blocks. The LA\_LegalSpace-BuildingUnit can be used for the building registration.

### Instance level diagrams

This section presents instance level diagrams for various cases, as examples, helping someone to better understand the implementation of the proposed model.

#### Residence right

A residence right is a right of a party over a house property (spatial unit) belonging to another party, to live in the house for a specified time period, or for the rest of his/her life. The residence right is actually a type of a usufruct right. (In Cyprus, it is very common for a parent to transfer the ownership right of his/her residence house to his/her son or daughter and at the same time to keep the ‘residence right’ for his/her benefit) (see Fig. 12).

#### Right of passage

A right of passage is an easement attached to a parcel (also see [8]). It is a right of way to a parcel (spatial unit), through another parcel. (The right for the first parcel is at the same time a restriction of passage to the second parcel). In the example shown in Fig. 13, parcel B has a right of passage through parcel A. The right of parcel B is at the same time a restriction of passage of parcel A, and both are attached to the parcels (not to the owners).

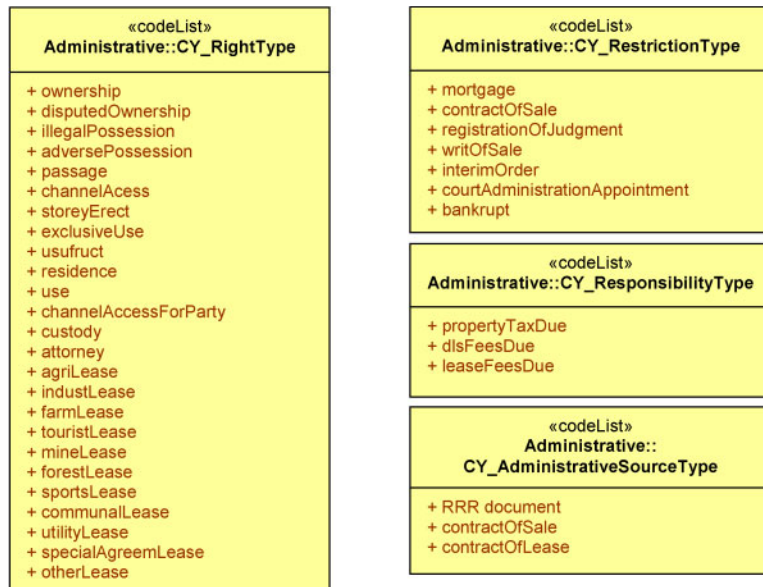
#### Channel access for party

Channel access could be a right of a party to channel water, liquid, electricity, wires, oil or gas through a channel, drain, mains or a pipe, placed on, under or above a spatial unit. The right of the party is at the same time a restriction on the related spatial units crossed by the channel. Note that in the future the 3D legal space around the channel itself may be registered via ownership, but also in that case the channel access rights via ‘surface’ parcels may be relevant. Baunit can be used for this type of combination. An example of such a right is the south irrigation underground water pipe, which has a length of 110 km, and is registered for the benefit of the state (Fig. 14).

#### Leases

A lease is a right of a party (lessee/tenant) over a spatial unit (parcel or house) belonging to another party (lessor/





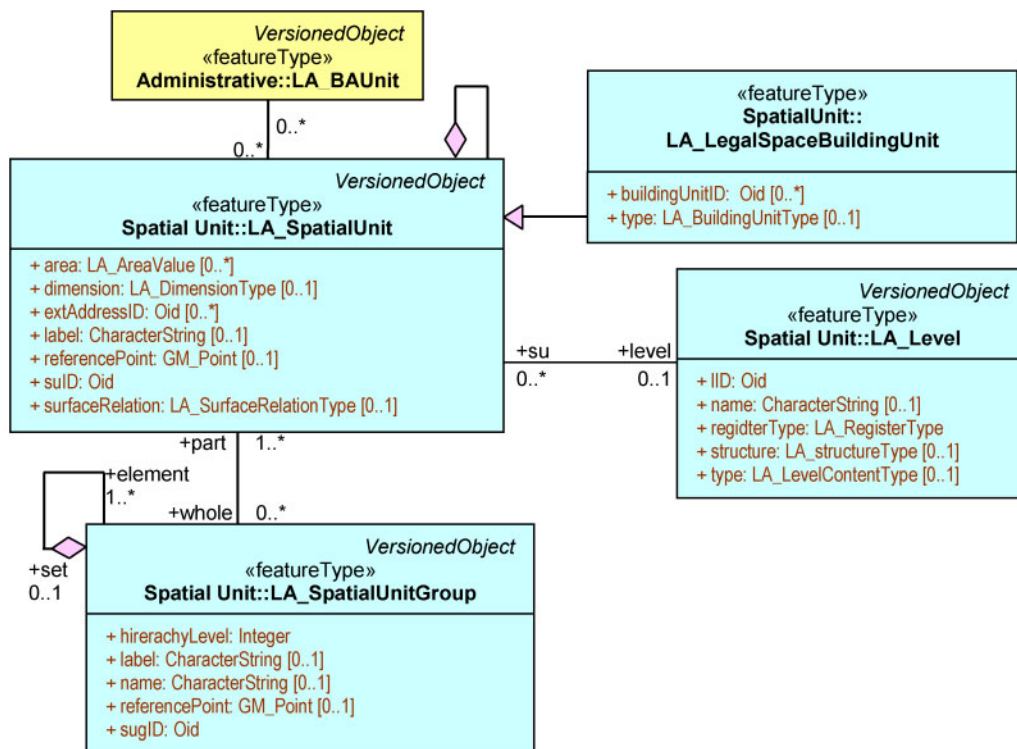
10 Code lists of the Cyprus proposed administrative package

freeholder), created as a result of a contract agreement between the involved parties, usually in consideration of rent, either for a specified time or for a period terminable at the will of either party. In Cyprus, leases usually concern state land, with the state being the freeholder. According to the purpose for which the lease is conducted, there are various categories of leases, which could be added in the code list of rights, as separate RightTypes. The example in Fig. 15 shows the lease of an agriculture parcel. The owner of the parcel is the Republic of Cyprus. The leaseholder is ‘Farmer1’ and he has to pay for the lease €200 per year (every April).

### Conclusions and future work

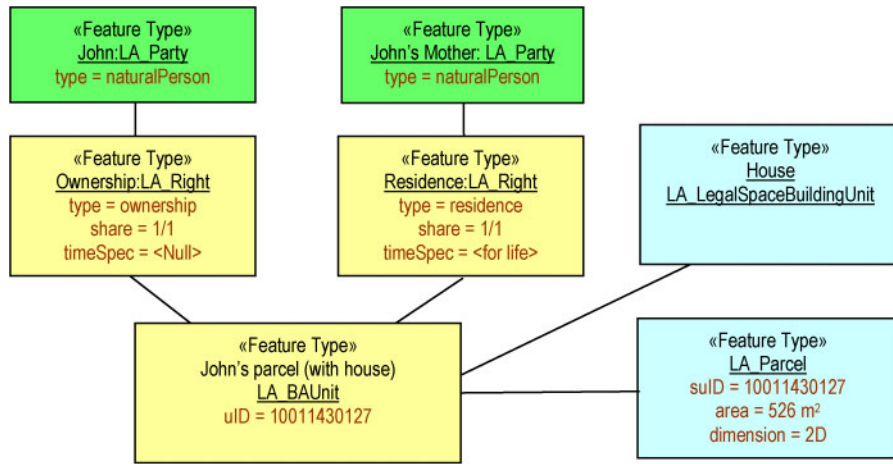
The introduction of a new data model is necessary to enhance the existing system, to facilitate the management of data, to reduce data duplication and to improve data integrity. This emerging need for a new CLIS data model coincides with the introduction of the LADM, which is under development within the TC211 of the ISO [5] and identified as ISO 19152.

A comparison of CLIS entities with LADM classes indicated that there is compatibility between the two and that LADM can be used as the reference model for the enhancement of CLIS. The core entities of CLIS should



11 The spatial unit class and its association with LA\_BAUnit, in the proposed CLIS data model, based on LADM

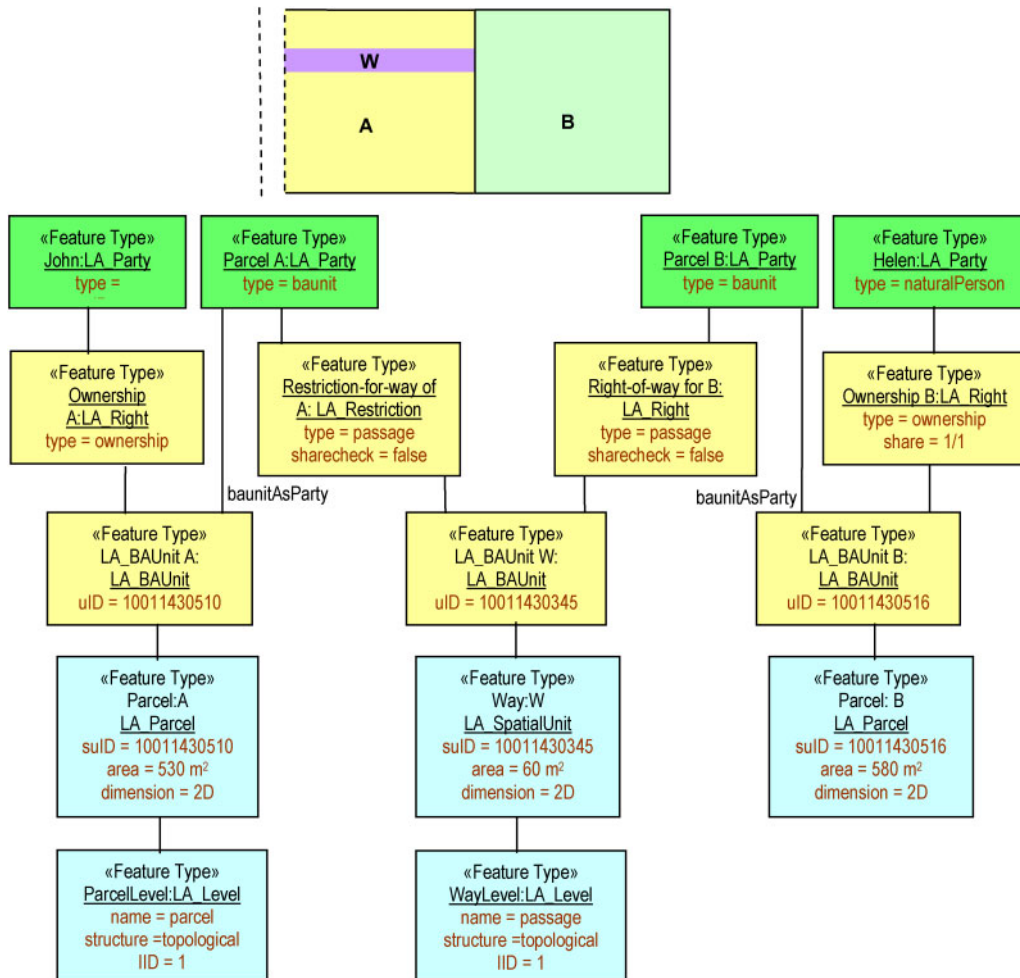




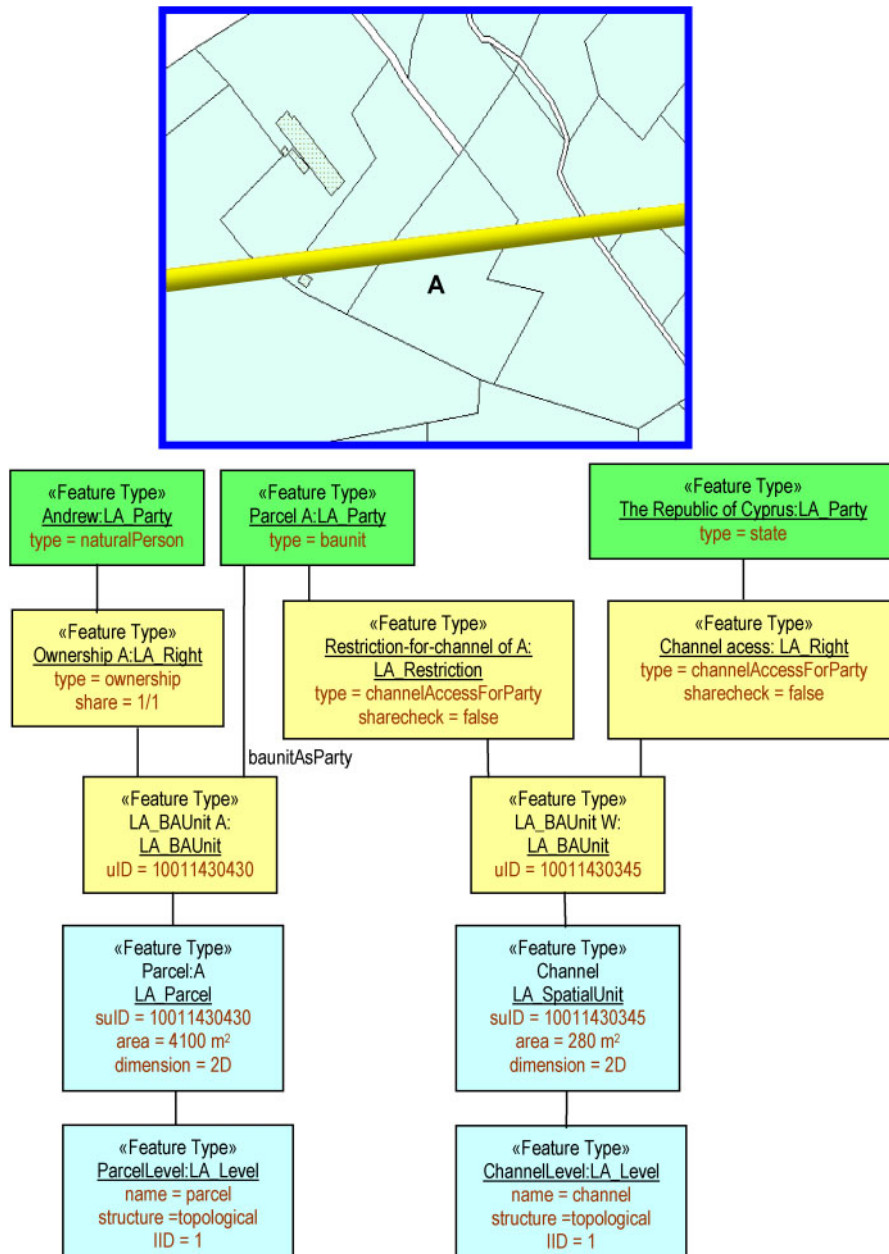
12 John's mother transferred the ownership right of her parcel (with house) to John, keeping at the same time the residence right for herself, for the rest of her life

be transferred to LADM classes, as follows: CY\_LegalBody to LA\_Party, CY\_Ownership to LA\_RRR, CY\_Agreements to LA\_RRR, CY\_Property to LA\_BAUnit and CY\_Parcel to LA\_SpatialUnit. The introduction of LADM will result in a more rigid structure and efficient administration of all RRR in CLIS. The RRR are classified and separated in various categories.

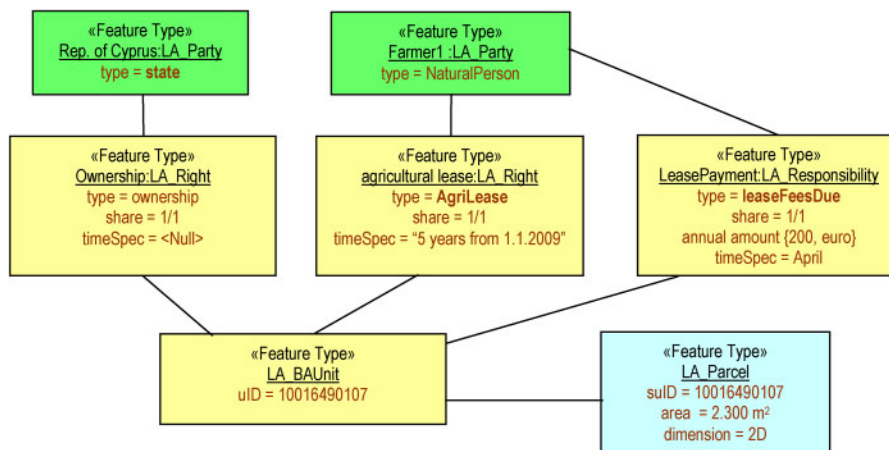
The rights are classified to: rights related to ownership, easements and other rights attached to parcel units, easements and other rights attached to parties, and lease rights. The restrictions are classified to: restrictions attached to parcel units and restrictions attached to parties. Furthermore, the 'administrative source' class of LADM will solve the problem of handling the legal



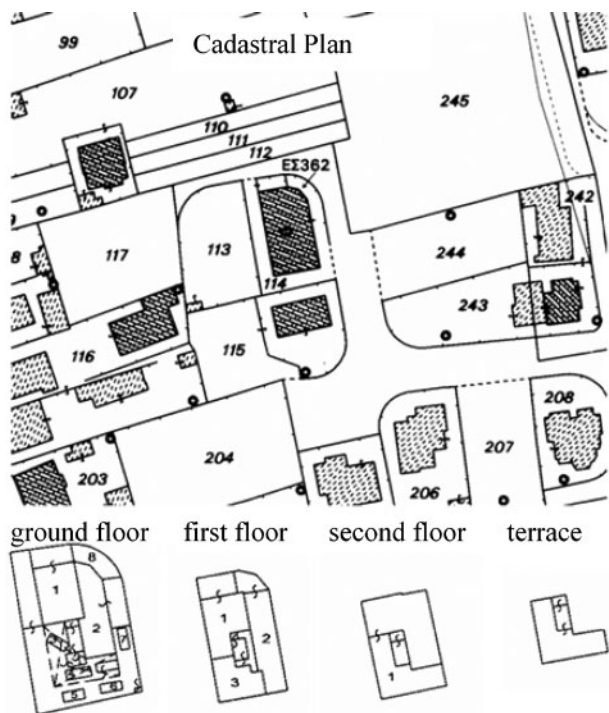
13 Parcel B has a right of passage through parcel A. This right is a restriction of passage of parcel A, and both are attached to the parcels (not to the owners). The restriction (negative side) could automatically be determined based on the geometry, and not included in the diagram



14 South irrigation underground water pipe. The channel access right is registered for the benefit of the state. The right of the state is at the same time a restriction-for-channel over all affected parcels. In this example, the right/restriction rights are given for only one parcel (parcel A). The restriction (negative side) could automatically be determined by polygon overlay based on the geometry, and not included in the diagram



15 Lease of a parcel, owned by the state, to a farmer



**16** In the case of a horizontal (strata) division, special plans are prepared for the ground and the other floors, as well as the terrace. On the cadastral plan, a reference number (EΣ 362) provides the reference to the special plan. In the future, these could be replaced by true 3D representations (for better recording of legal reality and easier access and visualisation)

paper documents, required for the operation of the Cyprus land administration system.

The conclusion of this investigation is that the adoption of LADM is a great opportunity for the Cyprus DLS to introduce an ISO standard model, improving and expanding the services provided by CLIS and the broader land administration system to the Cyprus community.

The future work and related R&D activities include: further modelling of the spatial sources (relevant parts of the Cyprus digital cadastral database and survey database in terms of the LADM surveying and spatial representation subpackage), implementation of the Cyprus LADM country profile (probably first in prototype for pilot), and further exploring of the possibilities to benefit from the 3D capabilities for registering spatial units related to apartments, subsurface channels, etc. Currently, in case of apartments, a special drawing plan indicates the boundaries of the apartment units. These special plans are made in 2D (for each floor level) (see Fig. 16). The Cyprus Immovable Property (Tenure Registration and Valuation) Law, Cap 224, article 5 specifies that 'Private ownership of any land shall extend to the surface and to

the substance of the earth beneath the surface and to the space above the surface, reasonably necessary for the enjoyment thereof, but not extend to minerals'. Therefore, some modification in this law is needed. In the case of the strata division, the owners get title certificates for each apartment and they can be co-owners of the parcel-lot on which the building is built and they are co-owners of common areas. Instead of separate floor plans, in the future integrated and true 3D spatial units could be used for both the individual apartments (units) and shared spaces. This will not only give everybody a more precise representation and more natural 3D interface to the RRR, but also will allow modelling of more complicated 3D situations, which cannot be captured by separate floor representations.

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## References

1. Department of Lands and Surveys, 1996. System Design Document of Cyprus Land Information System. Nicosia, Cyprus.
2. Elia, E., 2010. The Restructuring of Rights, Restrictions and Responsibilities (RRR), in the Cyprus Land Information System, in order to comply with the Land Administration Domain Model (LADM). *Proceedings of the International Federation of Surveyors (FIG) Commission 7 Annual Meeting*. 6–10 September, Karlovy Vary, Czech Republic.
3. Hespanha, J., Jardim, M., Paasch J. and Zevenbergen, J., 2009. Modelling Legal and Administrative Cadastral Domain: Implementation in the Portuguese Legal Framework. *The Journal of Comparative Law*, 4(2009)1: 140–169.
4. ISO, CEN TC287/WG 3, 2009. Geographic Information – Land Administration Domain Model. Technical Report draft of ISO 19152 (N1360), ISO, Geneva, Switzerland.
5. ISO/TC211, 2010. www.isotc211.org.
6. ISO, 2011. ISO 19152. Draft International Standard (DIS), Geographic information – Land Administration Domain Model (LADM). Geneva, Switzerland.
7. Kaufmann, J. and Steudler D., 1998. Cadastre 2014. A Vision for a Future Cadastral System. *Proceedings of FIG-Commission 7*. 19–25 July, Brighton, UK.
8. Lemmen, Ch., van Oosterom, P., Eisenhut, C. and Uitermark, H., 2010. The Modelling of Rights, Restrictions and Responsibilities (RRR) in the Land Administration Domain Model (LADM). *Proceedings of FIG Congress 2010*. 11–16 April, Sydney, Australia.
9. Lemmen, Ch., van Oosterom, P., Thompson, R., Hespanha, J. and Uitermark, H. 2010. The Modelling of Spatial Units (parcels) in the Land Administration Domain Model (LADM). *Proceedings of FIG Congress 2010*. 11–16 April, Sydney, Australia.
10. van Oosterom, P., Stoter, J., Ploeger, H., Thompson, R. and Karki, S., 2011. World-Wide Inventory of the Status of 3D Cadastres in 2010 and Expectations for 2014. *Proceedings of FIG Working Week 2011*. Bridging the Gap between Cultures. 18–22 May, Marrakech, Morocco.