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Geographic information — Land Administration Domain Model (LADM)

Information géographique — Modèle du domaine de l'administration des terres(LADM)

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19152 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

Introduction

This International Standard (IS) defines the Land Administration Domain Model (LADM). LADM is a conceptual schema and not a data product specification (in the sense of ISO 19131 Data Product Specification).

Land administration is a large field; the focus of this International Standard is on that part of land administration that is interested in rights, responsibilities and restrictions affecting land (or water), and the geometrical (spatial) components thereof. LADM provides a reference model which will serve two goals: (1) to provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on a Model Driven Architecture (MDA), and (2) to enable involved parties, both within one country and between different countries, to communicate, based on the shared vocabulary (that is, an ontology) implied by the model. The second goal is relevant for creating standardized information services in a national or international context, where land administration domain semantics have to be shared between regions, or countries, in order to enable necessary translations. Four considerations during the design of the model were: (1) it should cover the common aspects of land administration all over the world; (2) it should be based on the conceptual framework of 'Cadastre 2014' of the International Federation of Surveyors (FIG); (3) it should be as simple as possible, in order to be useful in practice; (4) the spatial aspects follow the ISO TC211 conceptual model.

The statements and principles of 'Cadastre 2014' are for this International Standard reformulated into seven *design principles*:

1. Principle of *spatial units*. The land ownership parcel of traditional cadastres should be extended to also include and administer all spatial units, which have some social, legal or economic relevance.
2. Principle of *the documentation of private and public rights, restrictions and responsibilities*. Not only ownership rights will be documented, but also the rights, restrictions and responsibilities established by different legislations having an impact on land shall be registered. In LADM this is extended with customary and informal rights.
3. Principle of *legal* independence. To be able to build a land administration system, it is necessary to investigate the laws in a jurisdiction and to identify those with an effect on land. The different spatial units are to be arranged according to the laws by which they are defined. This structure allows the immediate adaptation of the land administration to the development of the legislation. It is not necessary to rearrange the information. New legal topics can simply be added by including a further information level. If a law is cancelled, the respective information level can be removed without reorganizing the other levels. In this way it is possible to deal with facts which are not formally written down in a law. Such informal and customary rights exist where tribes or clans are obeying unwritten rules. These tribes or clans may have living, hunting and fishing rights within a defined territory from which the boundaries are known, but not documented formally. The rightful claimants are certainly able to localize the outlines of their rights and the respective spatial unit can be included into the land administration system. A form of 'occupation rights' exist in informal settlements in many areas of the world. Even when the occupation of the land may be contrary to the formal law, the rights of the involved settlers are informally defined by an unwritten code. The boundaries resulting from these informal arrangements can be localized and documented. So this principle can show overlapping rights and serve to formalize the situation, to regulate transactions, to monitor and to improve ambiguous situations. Indigenous rights normally overlap with a formal ownership system. The rights and the boundaries where they are in effect are well known and can be documented.
4. Principle of *linking objects by geometry*. The realization of the principle of legal independence results in a structure of independent topics. Spatial units are arranged in independent topics. In principle there is no explicit link between spatial units in different topics, and links between spatial units are normally not stored in the system but may be created when needed with the help of a spatial overlaying technique. However, in LADM this is extended with the possibility to store links between spatial units if needed.
5. Principle of *unified Cadastre and Land Registry*. Spatial units are linked directly with the information needed for registration.

6. Principle of *Land Administration Modelling*. The idea is to model objects in stead of thinking in graphical categories. Maps have no function as information repositories; their only purpose will be the visualization of information.
7. Principle of *Information and Communication Technology (ICT) application*. This principle implies that ICT is the best technical tool for land administration and the only way to achieve a low-cost land administration system.

It should be noted that although this is a land administration domain model, it is not intended to be complete for any particular country. It should be expandable and it is likely that additional attributes, operators, associations, and perhaps new classes, will be needed for a specific region or country; see for example the Social Tenure Domain Model (STDM) in Annex B, the country profiles in Annex D, or the integration of LADM with Land Parcel Identification Systems (LPIS) of the European Union in Annex H. Conversely, it is possible to use only a subset, or profile, of LADM for a specific implementation. Furthermore, the model supports the increasing use of 3D representations of objects (spatial units).

Until now, most countries (or states, or provinces) have developed their own land administration system. One country operates deeds registration, another title registration. Some systems are centralized, and others decentralized. Some systems are based on a general boundaries approach, others on fixed boundaries. Some systems have a fiscal background, others a legal one. The different implementations (foundations) of the various land administration systems do not make meaningful communication across borders easy. However, looking from a distance, one may observe that the different systems are in principle largely the same: they are all based on the relationships between people and land linked by (ownership or use) rights, and are in most countries influenced by developments in Information and Communication Technology (ICT). Furthermore, the two main functions of every land administration (including cadastre and/or land registry) are: (1) keeping the contents of these relationships up-to-date (based on regulations and related transactions); and (2) providing information from the (national) registers.

Land administration is described as the process of determining, recording and disseminating information about the relationship between people and land. If ownership is understood as the mechanism through which rights to land are held, we may also speak about land tenure. A main characteristic of land tenure is that it reflects a social relationship regarding rights to land, which means that in a certain jurisdiction the relationship between people and land is recognised as a legally valid one. These recognised rights are in principle eligible for registration, with the purpose being to assign a certain legal meaning to the registered right (e.g. a title). Therefore, land administration systems are not just 'handling geographic information', as they represent a lawfully meaningful relationship amongst people, and between people and land. As land administration activity on the one hand deals with huge amounts of data, which moreover are of a dynamic nature, and on the other hand requires a continuous maintenance process, then the role of ICT is of strategic importance. Without the availability of information systems it will be difficult to guarantee good performance with respect to meeting changing customer demands. Organizations are now increasingly confronted with rapid developments in technology, a technology push (internet, spatial data bases, modelling standards, open systems, GIS), as well with a growing demand for new services, a market pull (e-governance, sustainable development, electronic conveyance, integration of public data and systems). Modelling is a basic tool facilitating appropriate system development and reengineering and, in addition, it forms the basis for meaningful communication between different systems.

Standardization has become a well-known process in the work of land administrations and land registries. In both paper-based systems and computerized 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. Computerized systems require further standardization, when topology and the identification of single boundaries are introduced. In existing land administrations and land registries, standardization is generally limited to the region, or jurisdiction, where the land administration (including cadastre and/or land registry) is in operation. Open markets, globalization, and effective and efficient development and maintenance of flexible (generic) systems, require further standardization.

Review history

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Geographic information — Land Administration Domain Model (LADM)

1 Scope

This International Standard:

- defines a reference Land Administration Domain Model (LADM) covering basic information-related components of Land Administration (including those over water as well as land, and elements above and below the surface of the earth)
- provides an abstract, conceptual schema with five basic packages related to (1) parties (*people and organizations*); (2) basic administrative units, rights, responsibilities, and restrictions (*ownership rights*); (3) spatial units (*parcels, buildings and networks*); (4) spatial sources (*surveying*); and (5) spatial representations (*geometry and topology*)
- provides a terminology for land administration, based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions
- provides a basis for national and regional profiles, and
- enables the combining of land administration information from different sources in a coherent manner.

The following is outside the scope of this International Standard:

- interference with (national) land administration laws that may have any legal implications
- construction of external databases with party data, address data, valuation data, land use data, land cover data, physical network data, archive data, and taxation data. However, LADM provides 'blueprint' stereotype classes for these data sets which indicate what data set elements LADM expects from these external sources, if available, and
- modelling of land administration processes.

2 Conformance

Any land administration domain model claiming conformance to this International Standard shall satisfy the requirements of Annex A.

3 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of the International Standard. For dated references, subsequence amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

ISO 4217:2008, C*urrency names and code elements*

ISO 13240:2001, *Interchange Standard for Multimedia Interactive Documents (ISMID)*

ISO 14825:2004, In*telligent transport systems Geographic Data Files (GDF) – Overall data specification*

ISO 19103:2005, G*eographic Information – Conceptual schema language*

ISO 19105:2000, *Geographic Information – Conformance and testing*

ISO 19106:2004, G*eographic Information – Profiles*

ISO 19107:2003, *Geographic Information – Spatial schema*

ISO 19108:2002, *Geographic Information – Temporal schema*

ISO 19111:2007, G*eographic Information – Spatial referencing by coordinates*

ISO 19115:2003, *Geographic information – Metadata*

ISO 19125-2:2004, *Geographic information – Simple feature access -- Part 2: SQL option*

ISO/CD 19156, Geographic information – *Observations and measurements*.

4 Terms, definitions, and abbreviations

4.1 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

4.1.1 administrative source

source with the administrative description (where applicable) of the p**arties** involved, the **rights**, **restrictions** and **responsibilities** created and the **basic administrative units** affected

EXAMPLE 1. It is the evidence of a **party's right** to a **basic administrative unit**.

EXAMPLE 2. A document describing a transaction (a deed), or a judgement of the register holder.

4.1.2 basic administrative unit (baunit)

administrative entity consisting of zero or more **spatial units** against which (one or more) unique and homogeneous **rights** (e.g. ownership **right** or land use **right**), **responsibilities** or **restrictions** are associated to the whole entity, as included in a Land Administration system

NOTE 1. By unique is meant that a **right**, or **restriction**, or **responsibility** is held by one, or several **parties** (e.g. owners or users) for the whole **basic administrative unit**. By homogeneous is meant that a **right**, or **restriction**, or **responsibility** (e.g. ownership, use, social tenure, lease, or easement) affects the whole **basic administrative unit**.

NOTE 2. To cater for the design principle of legal independence **rights**, **restrictions**, and **responsibilities** may be assigned to **basic administrative units**.

NOTE 3. An **basic administrative unit** may play the role of **party**.

EXAMPLE. A condominium unit with two **spatial units** (e.g. an apartment and a garage), or a farm lot made of one **spatial unit** (e.g. parcel of land), a servitude made of one **spatial unit** (e.g. the road representing the right-of-way), or a land consolidation area.

4.1.3 boundary face

2-dimensional (2D) topological primitive

NOTE 1. This standard supports both 2-dimensional (2D), 3-dimensional (3D), or mixed (2D and 3D) representations of **spatial units**.

NOTE 2. **Boundary faces** are used for 3D representation of **spatial units**.

EXAMPLE. **Boundary faces** are used where unbounded volumes are not applicable. **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).

4.1.4 boundary face string

boundary forming part of the outside of a **spatial unit**

NOTE 1. This 2D representation implies in a 2D land administration system a 2D boundary, or in a 3D land administration system a series of vertical **boundary faces**. In that case an unbounded volume is assumed,

surrounded by **boundary faces**, which intersect the earth's surface (such as traditionally depicted in the cadastral map).

NOTE 2. A **boundary face string** is represented in 2D as GM_MultiCurve.

4.1.5 building unit

component of building (the legal, recorded or informal space of the physical entity)

NOTE. A building unit is for different purposes (e.g. living or commercial), or it can be a construction work.

EXAMPLE. An apartment, a stairs, a threshold, a garage, a parking place, or a laundry space.

4.1.6 coordinate reference system

set of mathematical rules for specifying how coordinates (one of a sequence of n numbers designating the position of a point in n-dimensional space) are to be assigned to points that are related to the real world by a datum (parameter or set of parameters that serve as a reference or basis for the calculation of other parameters)
[from ISO 19111: 2007]

4.1.7 group party

any number of **parties**, forming together a distinct entity, with each **party** registered

NOTE. A **group party** may be a **party member** of another **group party.**

EXAMPLE. A partnership (with each partner registered as a **party**), or two tribes (with each tribe registered as a **party**).

4.1.8 land administration

the process of determining, recording and disseminating information about the relationship between people and land

NOTE. In many countries land administration information is determined, recorded and disseminated under the umbrella of cadastre and land registry. Both institutions can be unified in a single (state) organization.

4.1.9 level

collection of **spatial units** with a geometric and/or thematic coherence

EXAMPLE 1. One **level** for an urban cadastre and another **level** for a rural cadastre.

EXAMPLE 2. One **level** with **rights** and another **level** with **restrictions**.

EXAMPLE 3. One **level** with formal **rights**, a second **level** with informal **rights** and a third **level** with customary **rights**.

EXAMPLE 4. One **level** with point based **spatial units**, a second **level** with line based **spatial units**, and a third **level** with polygon based **spatial units**.

4.1.10 liminal spatial unit

spatial unit on the threshold between 2D and 3D representations

4.1.11 network

the description of the legal, recorded or informal space of a utility network

NOTE. A network can also be modelled as a **basic administrative unit.**

EXAMPLE. The legal space needed to access and to keep in repair a cable or pipeline network.

4.1.12 party

persons, or group of persons, or juridical persons that compose an identifiable single (legal) entity, or a **basic administrative unit**

NOTE 1. In order to be registered as a **party** not all members need to be identified and registered individually.

NOTE 2. A **basic administrative unit** may be a **party** because it may hold a **right** of e.g. easement.

EXAMPLE. A juridical person may be: a company, a municipality, the state, a tribe, a farmer cooperation, or a church community (with each juridical person represented by a delegate: a director, chief, CEO, etc.).

4.1.13 party member

a **party** registered and identified as a constituent of a **group party**

4.1.14 point

point derived from a **spatial source** which may be used to define one or more **boundary faces** or **boundary face strings**

NOTE. This can be observed by e.g. terrestrial surveying, but also by photo interpretation, image interpretation, or identification on an existing map.

4.1.15 profile

set of one or more base standards or subsets of base standards, and, where applicable, the identification of chosen clauses, classes, options and parameters of those base standards, that are necessary for accomplishing a particular function
[from ISO 19106: 2006]

4.1.16 required relationship

explicit association between **spatial units**

NOTE 1. Due to inaccuracies or missing geometries, spatial overlay may generate invalid or no relationships between **spatial units**, which can be corrected using required relationships.

NOTE 2. The type of relationship is defined in ISO 19125-2.

4.1.17 responsibility

formal or informal obligation to do something

EXAMPLE. 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.

4.1.18 restriction

formal or informal entitlement to refrain from doing something

EXAMPLE. It is not allowed to built within 200 metres of a fuel station; or, a servitude or mortgage as a **restriction** to the ownership **right**.

4.1.19 right

formal or informal entitlement to own, to do something

NOTE 1. A **right** may be a personal **right** (e.g. fishing, grazing, or using), or a real **right** (e.g. ownership, or usufruct).

NOTE 2. **Rights** may be overlapping, or may be in disagreement.

NOTE 3. This International Standard deals both with real **rights** (e.g. ownership **right**) and personal **rights** (e.g. land use **right**).

EXAMPLE. Ownership **right**, apartment **right**, tenancy **right**, possesion, customary **right**, islamic **right** (e.g miri or milk), indigenous **right**, or informal **right**.

4.1.20 source

document providing facts

NOTE. Any kind of document may be added as a **source** according to ISO 19115, section B3.2.

4.1.21 spatial source

source with the spatial representation of one (part of) or more **spatial units**

EXAMPLE. A field survey sketch, an orthophoto, or a satellite image with evidence on the location of boundaries (collected from the field).

4.1.22 spatial unit

a single area (or multiple areas) of land or water, or a single volume (or multiple volumes) of space

NOTE 1. A single area is the general case and multiple areas are the exception.

NOTE 2. **Spatial units** are structured in a way to support the creation and management of **basic administrative units**.

NOTE 3. **Spatial units** may be represented: in text (“from this tree to that river”), or based on a single point, or as a set of unstructured lines, or as a surface, or as a 3D volume.

NOTE 4. Apart from **spatial units** represented with a single point, text, or a set of unstructured lines, a **spatial unit** may have an area equal to zero for administrative reasons.

4.1.23 spatial unit group

any number of **spatial units**, considered as an entity

NOTE. The **spatial units** in a **spatial unit group** are not necessarily continious.

EXAMPLE. **Spatial units** forming together an administrative zone such as a section, a canton, a municipality, a department, a province, or a country. **Spatial units** within a planning area.

4.2 Abbreviations

baunit	Basic administrative unit
FIG	International Federation of Surveyors
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
INSPIRE	INfrastructure for SPatial Information in Europe
LA	Land Administration
LADM	Land Administration Domain Model
RRR	Right, Restriction, Responsibility
STDM	Social Tenure Domain Model
UML	Unified Modelling Language

5 Overview of LADM

5.1 Basic packages of LADM

LADM is a conceptual schema (as a product). LADM consist of three packages and two subpackages. A (sub)package is a group of classes (each with its own namespace). This facilitates the maintenance of different data sets by different organizations. The complete model may therefore be implemented through a distributed set of (geo-) information systems, each supporting data maintenance activities and the provision of elements of the model. The model may also be implemented by one or more maintenance organizations operating at national, regional or local level. This underlines the relevance of the model: different organizations have their own responsibilities in data maintenance and supply, but may communicate on the basis of standardized administrative and technical update processes.

An overview of the packages (with their respective classes) is presented in Figure 1 as an UML 2.1 package diagram. The packages are: Party (Clause 5.3), Administrative (Clause 5.4), and Spatial Unit (Clause 5.5). Surveying (Clause 5.5.1) and Spatial Representation (Clause 5.5.2) are subpackages of the Spatial Unit package.

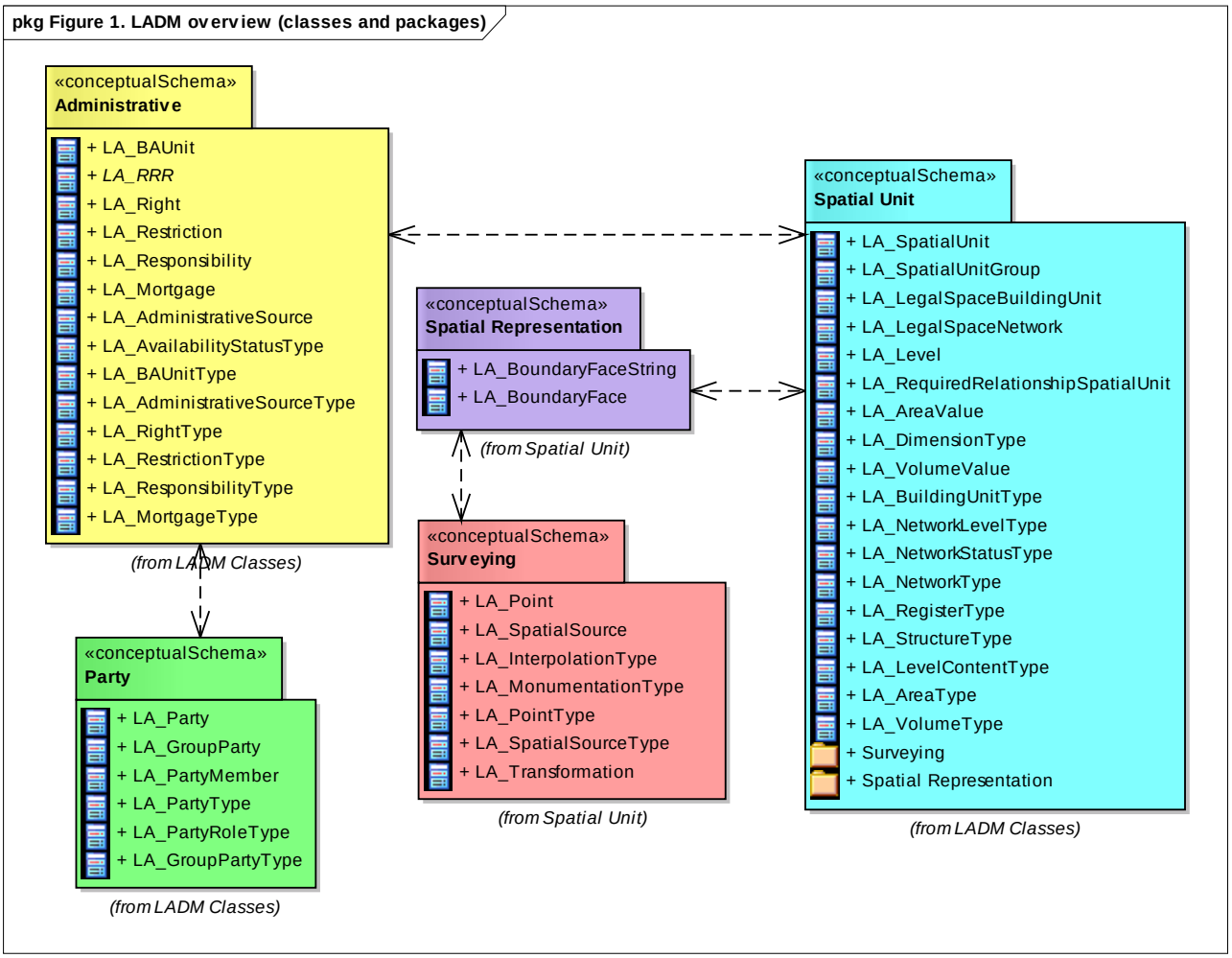


Figure 1. LADM overview of packages (with their respective classes)

5.2 Basic classes of LADM

The core LADM is based on four classes:

1. Class LA_Party. Instances of this class are *parties*.
2. Class LA_RRR. Instances of subclasses of LA_RRR are *rights, restrictions or responsibilities*.
3. Class LA_BAUnit. Instances of this class are *basic administrative units*.
4. Class LA_SpatialUnit. Instances of this class are *spatial units*.

Figure 2 shows the core LADM as an UML 2.1 class diagram. The content of these four basic classes, and all other LADM classes are presented in Clause 6.

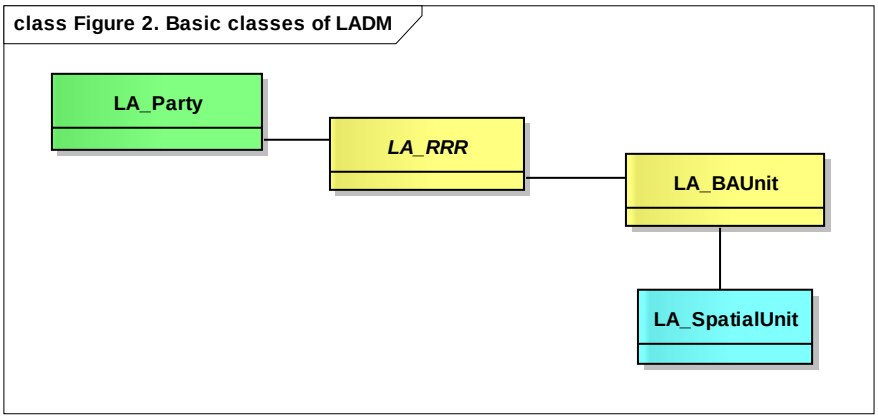


Figure 2. Basic classes of LADM

5.3 Party Package

The main class of this package is the basic class LA_Party (with 'party' as an instance; see Clause 4.1.12), with its specialization LA_GroupParty (with 'group party' as an instance; see Clause 4.1.7). There is an optional association class LA_PartyMember (with 'party member' as an instance; see Clause 4.1.13). See Figure 3.

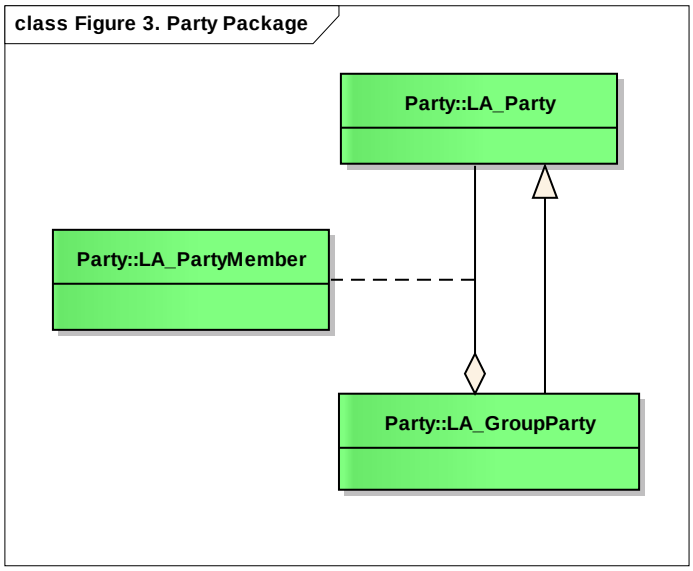


Figure 3. Classes of Party Package and associations between them

A 'group party', being a specialization of 'party', is also a 'party'. That means that the aggregation relationship between LA_Party and LA_GroupParty in Figure 3 creates 'group parties' with (registered)

'parties' as constituents. Every 'party', being a constituent of a 'group party', may then be registered as a 'party member' of class LA_PartyMember.

5.4 Administrative Package

The main classes of this package are the (abstract) basic class LA_RRR and basic class LA_BAUnit:

- LA_RRR has three specializations: LA_Right (with rights), LA_Restriction (with restrictions) and LA_Responsibility (with responsibilities). In principle, all rights, restrictions and responsibilities are based on an administrative source (from class LA_AdministrativeSource)
- LA_BAUnit with basic administrative units ('baunits').

See Figure 4.

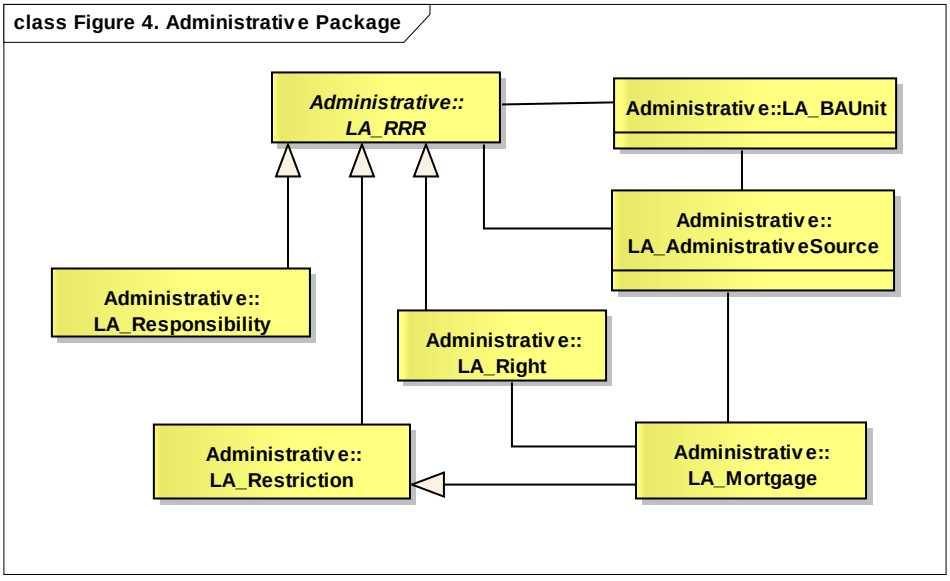


Figure 4. Classes of Administrative Package and associations between them

Each jurisdiction has a different 'land tenure system', reflecting the social relationships regarding rights, restrictions, and responsibilities to 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 (which can be areas with customary tenures). The aforementioned rights are primarily in the domain of private, or customary law. Usually the rights are created after an agreement between the party obtaining the right and the party (e.g. the land owner) who restricts his or her right by the newly created right. The restrictions usually "run with the land", meaning that they remain valid even when the right to the land is transferred after the right was created (and registered). Ownership rights are generally based on (national) legislation, and code lists in LADM are in support of this. A customary right related to a region, or an informal right may be included.

In addition to those private law restrictions, many countries also have public law restrictions, which are usually enforced by a (local) government body. The holder of the restriction is a party (either 'the government' or 'society-at-large'). Some of them apply to a specific spatial unit (or right therein), or a group of them, or concern the duty to pay a certain tax for improvements on a road, or the duty to repair damage, or perform delayed maintenance.

A restriction means that a party allows (formally or informally) another party to do something, or that a party shall refrain (formally or informally) from doing something itself. Restrictions are both within private law, especially in the form of servitudes, or within public law, through zoning and other planning restrictions, as well as in environmental limitations.

A mortgage (from class LA_Mortgage) is a special restriction to the ownership right. It concerns the conveyance of a property by a debtor to a creditor as a security for a financial loan with the condition that the property is returned when the loan is paid off.

A responsibility means that one shall actively do something. Not all formal systems allow such mandated activities as ownership rights, and this will also affect the question whether they shall be (or should be) registered. Their impact may be substantial, and their registration is therefore preferable.

There is always at least one instance of LA_Right in which the type of right represents the strongest (or primary) right, for instance customary or statutory ownership, freehold or leasehold. Connected to this strongest right, certain interests may be added or subtracted from this strongest right.

Restrictions can be seen from a 'positive' or 'negative' side: the fact that a neighbour is allowed to walk over your land is an additional right (appurtenance, positive-side) to the ownership right of the neighbour, whereas it is a restriction (encumbrance, negative-side) to your ownership.

Both sides can be represented. If the negative-side can be derived (computed), then only the positive-side needs to be stored.

5.5 Spatial Unit Package

The main class of this package is basic class LA_SpatialUnit, with spatial units as instances. *LA_Parcel is an alias for this class.*

See Figure 5.

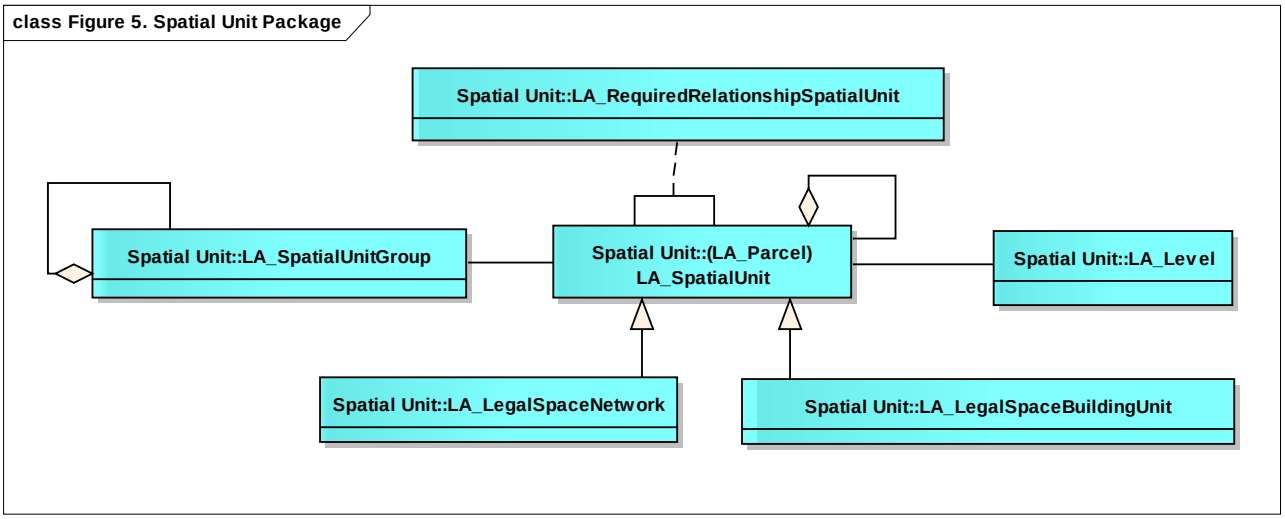


Figure 5. Classes of Spatial Unit Package and associations between them

Spatial units may be grouped into 'spatial unit groups', for example, a municipality. A spatial unit group may be a grouping of other spatial unit groups. In implementations of LADM, this may be related to spatial unit identifiers; when a spatial unit identifier is composed out of hierarchical zones, e.g. country id, followed by department id, followed by county id, followed by municipality id, etc.

Another grouping of spatial units is into their parts, or sub spatial units (*subparcels*), and parts may be grouped into their subparts, or subsub spatial units (*subsubparcels*), and so on.

Spatial units are refined into two specializations: (1) building units (in class LA_LegalSpaceBuildingUnit), and (2) networks (in class LA_LegalSpaceNetwork).

A level is a collection of spatial units with a geometrical/topological or thematic coherence. A level may be organized on the basis of the geometrical/topological structure of the spatial units, and is used for the

implementation of the notion of legal independence. This notion stipulates that spatial units, being subject to the same law and underlying a unique adjudication procedure, may be arranged in one individual level.

It is possible to establish explicit links between spatial units as instances of class LA_RequiredRelationship-SpatialUnit. Sometimes there is a need for these links when the geometry of the spatial units is not accurate enough to give reliable results when applying overlap operations (e.g. a building, in reality inside a parcel, is reported to fall outside the parcel; the same applies to the geometry of a right, e.g. an easement). Required relationships defined explicitly override implicit relationships established through spatial operations.

5.5.1 Surveying Subpackage

The two classes of this subpackage are LA_Point and LA_SpatialSource. See Figure 6.

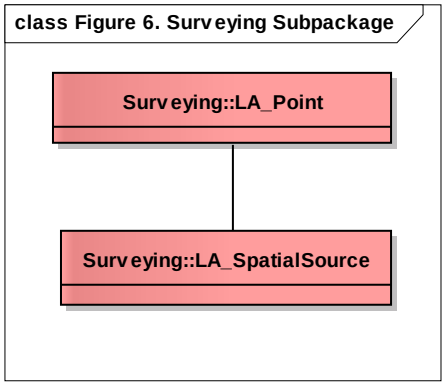


Figure 6. Classes of Surveying Subpackage and its association

Data acquisition can be conducted digitally in the field (with classical surveys, or with satellite navigation systems), in an office, or compiled from various sources, for example using forms and field sketches, ortho-images or ortho-photos. Surveys may concern the identification of spatial units on a photograph, an image or a topographic map; but cyclorama's or pictometry methods (multiple images from different angles) are also possible.

A land administration survey is documented with spatial sources (from class LA_SpatialSource). This may be the final (sometimes formal) document, or all documents related to a survey. Sometimes, several documents are the result of a single survey. A spatial source may be official or not (i.e. registered survey plan, or aerial photograph). Paper based documents (which may be scanned) should be considered as an integral part of the land administration system. 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 to LA_SpatialSource. While it is not required that the complete spatial unit is represented, a spatial source may be associated to several points.

Geodetic control points, including multiple sets of coordinates for points and supporting multiple reference systems are all supported in LADM.

5.5.2 Spatial Representation Subpackage

The two classes of this package are LA_BoundaryFaceString and LA_BoundaryFace. 2D and 3D representations of spatial units use boundary face strings and boundary faces as key concepts.
See Figure 7.

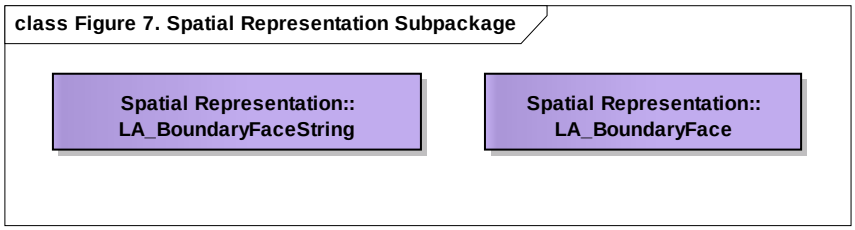


Figure 7. Classes of Spatial Representation Subpackage

Coordinates themselves are rooted in points of the Surveying Subpackage. All types of spatial units share the same description structure. Existing 2D data, whether topologically structured or not, or polygons, or unstructured boundaries, or simply point or textual descriptions, can be included. The model supports the increasing use of 3D representations of spatial units, without putting additional burden on the existing 2D representations. Another important requirement is that there is no mismatch between parts of the domain that are described in 2D and parts of the domain that are described in 3D. Further, LADM is based on accepted and available spatial schema's, such as published in ISO 19107.

6 Content of classes of LADM and their associations

6.1 Introduction

To differentiate LADM classes from other classes of ISO 19100 series, they are given LA_ as a prefix.

Furthermore, all LADM classes adhere to ISO 19103 stereotype class *FeatureType*. Many LADM classes are subclasses of class *VersionedObject* which is explained in Clause 6.2.1.

This standard presupposes so called 'blueprint' stereotype classes, with a minimal number of attributes, to address the situation where an LADM class refers to external sources for parties, addresses, taxations, land uses, land covers, valuations, utility networks, or archives.

LADM allows user-defined elements to be added. It is likely that additional attributes, operators, associations, or perhaps new classes, will be needed for a specific region or country. It is possible that parts of LADM may not be used at all. Therefore, profiles can be used for customizing LADM to meet specific needs. See Annex D. Country Profiles (informative).

6.2 Special classes

6.2.1 VersionedObject

This class is introduced in LADM to manage and maintain historical data in the database. This requires that inserted and superseded data are given a time-stamp. In this way, the contents of the database can be reconstructed, as they were at any moment in the past. Classes LA_Party, LA_PartyMember, LA_Mortgage, LA_RRR, LA_BAUnit, LA_SpatialUnit, LA_SpatialUnitGroup, LA_RequiredRelationshipSpatialUnit, LA_Level, LA_BoundaryFaceString, LA_BoundaryFace, and LA_Point are all subclasses of VersionedObject. See Figure 8.

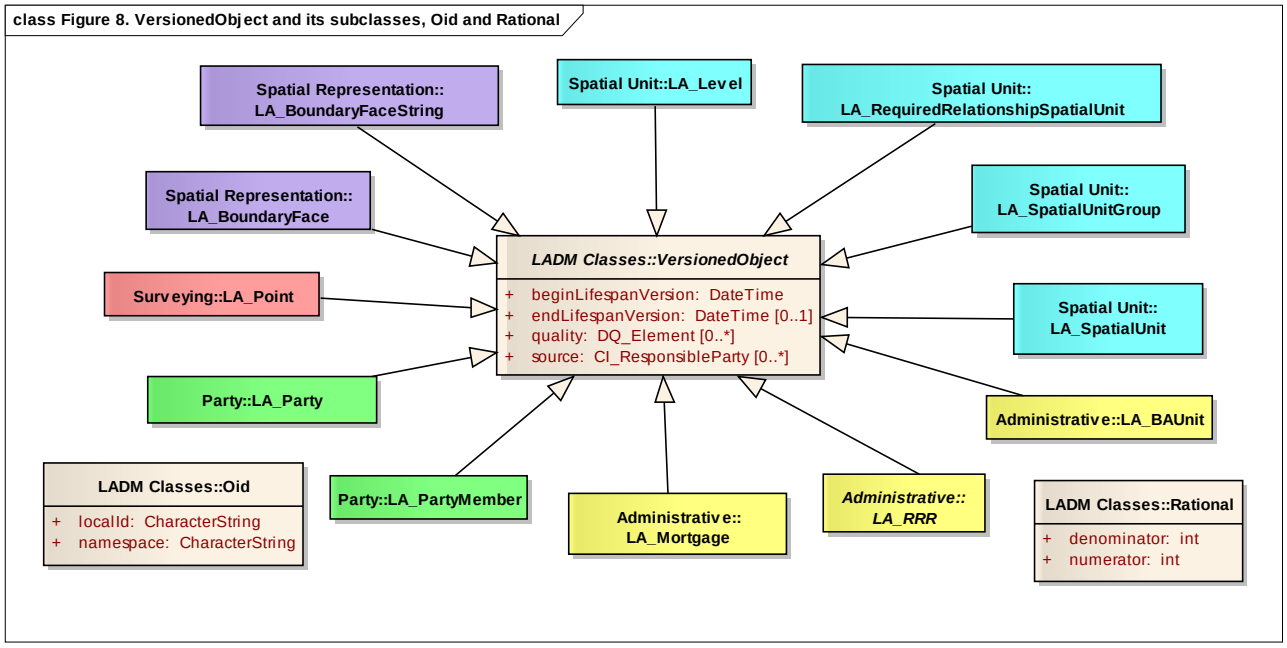


Figure 8. VersionedObject and its subclasses, Oid and Rational

The attributes of VersionedObject are:

- beginLifespanVersion: start time of a specific instance version (DateTime type from ISO 19103)
- endLifespanVersion: end time of a specific instance version
- quality: quality of a specific instance version; defined as DQ_Element in ISO 19113
- source: responsible organization of a specific instance version (CI_ResponsibleParty type from ISO 19115).

6.2.2 LA_Source

In LADM, sources are modelled, starting with an abstract class LA_Source. An instance of a subclass of class LA_Source is an administrative source (clause 6.4.7), or a spatial source (clause 6.6.2). See Figure 9.

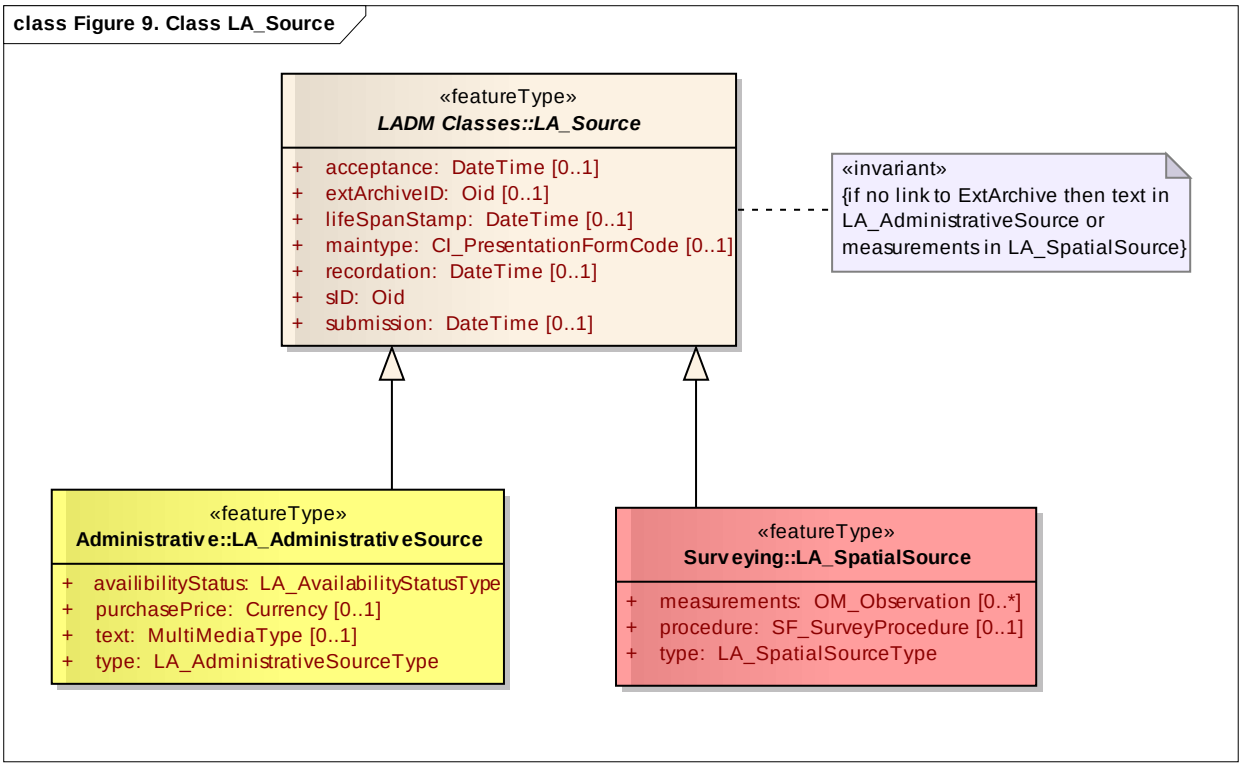


Figure 9. Class LA_Source

The attributes of LA_Source are:

- acceptance: the date of force of law of the source by an authority
- extArchiveID: the identifier of a source in an external registration (‘blueprint’ class ExtArchive)
- lifeSpanStamp: the moment that the event represented by the instance of LA_Source is further processed in the LA system; i.e. the moment of endLifeSpanVersion of old instances and beginLifeSpanVersion of new instances
- maintype: the type of document
- recordation: the date of registration (recordation) of the source by registering authority
- sID: the identifier of the source
- submission: the date of submission of the source by a party.

NOTE 1. The fact that all different (public or private law) rights find their base in some kind of transacting document is represented by the association between LA_RRR and LA_AdministrativeSource. The party responsible for drafting the document is connected to the latter as ‘conveyer’, ‘notary’, or ‘writer’ (see Figure 11).

NOTE 2. In some Land Administration systems sources are needed to perform the transactions but not archived afterwards. Then the registration itself provides evidence.

6.2.3 Rational

This generic class is introduced in LADM to provide support for rational numbers (fractions); e.g. ½ or ¾ . A fraction is written as a pair of numbers, the top number called the numerator and the bottom number called the denominator. A line usually separates the numerator and denominator. See Figure 8.

The attributes of Rational are:

- denominator: the bottom number in the notation of the fraction (non-zero integer)
- numerator: the top number in the notation of the fraction (integer).

6.2.4 Oid

This generic class is introduced in LADM to provide support for object identifiers See Figure 8.

The attributes of Oid are:

- localId: local identifier, assigned by the data provider (character string).
  The local identifier shall be unique within the namespace, i.e. no other spatial object should carry the same identifier. The local identifier should only use the following set of characters: {"A" …"Z", "a"…"z", "0"…"9", "_", ".","," "-",}, i.e. only letters from the Latin alphabet, digits, underscores, periods, commas, and dashes are allowed
- namespace: identifies the data source of the spatial object (character string).

6.3 Classes of Party Package

6.3.1 LA_Party

An instance of class LA_Party is a party. A party is associated to zero or more [0..*] instances of a subclass of LA_RRR. LA_Party is also associated to LA_BAUnit, to cater for the fact that a party can be an basic administrative unit (e.g. a basic administrative unit holding an easement on another basic administrative unit). See Figure 10.

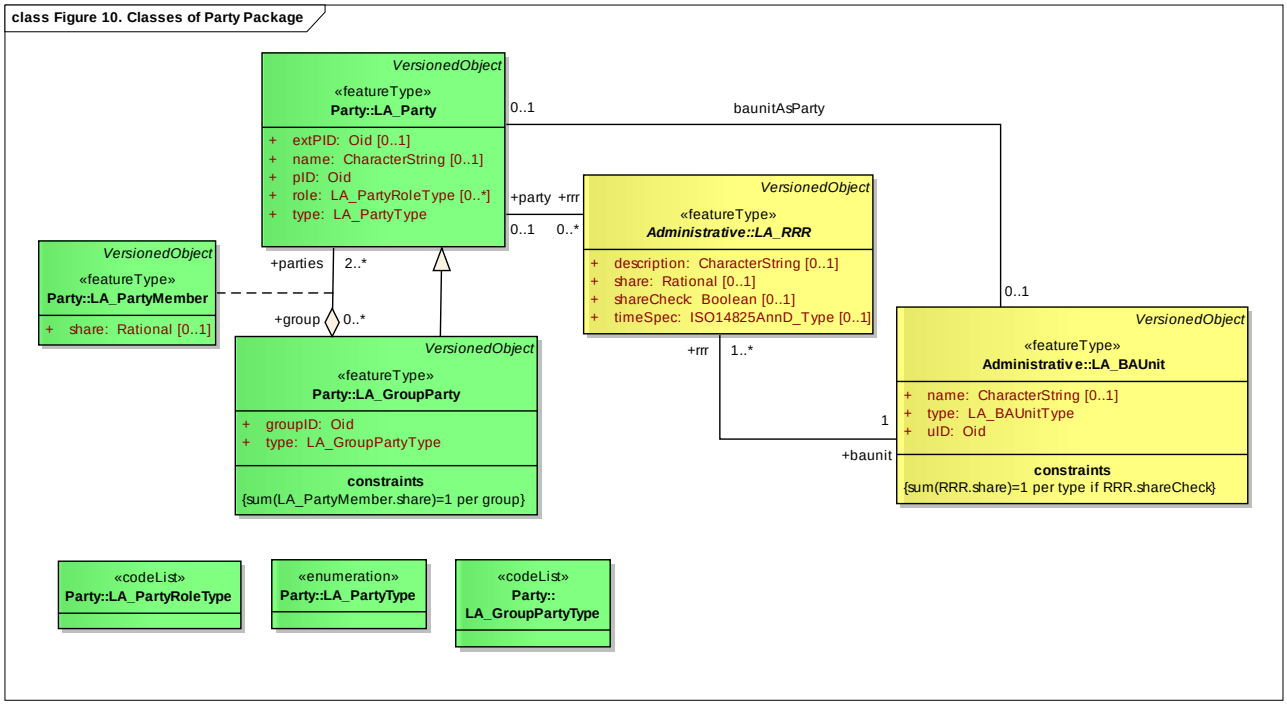


Figure 10. Content of Party Package and main associations to classes in other packages

The attributes of LA_Party are:

- extPID: the identifier of the party in an external registration ('blueprint' class ExtParty, which includes a reference to an external address)
- name: the name of the party
- pID: the identifier of the party

- role: the role of the party in the data update and maintenance process (e.g. conveyor, notary, writer, surveyor, certified surveyor, bank, money provider, employee, etc.). The attribute ‘role’ shall be represented as an instance of class LA_PartyRoleType.
- type: the type of the party (e.g. natural person, non natural person, group, basic administrative unit, etc.). The attribute ‘type’ shall be represented as an instance of class LA_PartyType.

NOTE. If ‘role’ has a specific value (e.g. conveyor) then it is possible that no RRR is associated to the party, hence [0..*] multiplicity, 0 indicating that e.g. this conveyor is not involved in any RRR.

6.3.2 LA_GroupParty

An instance of class LA_GroupParty is a group party. Class LA_GroupParty is a subclass of LA_Party, thus allowing instances of class LA_GroupParty to have an association with instances of class LA_RRR (and thereby also to class LA_BAUnit). A group party may consist of two or more [2..*] parties, but also of other group parties (that is to say, a group party of group parties). Conversely, a party is a member of zero or more [0..*] group parties. See Figure 10.

The attributes of LA_GroupParty are:

- groupID: the identifier of a group party
- type: the type of the group party (e.g. a tribe, an association, a family). The attribute ‘type’ shall be represented as an instance of class LA_GroupPartyType.

There is a constraint stating that the sum of the shares of the group party members is equal to 1. This constraint is only enforced if there exists a class LA_PartyMember (see Clause 6.3.3).

6.3.3 LA_PartyMember

An instance of class LA_PartyMember is a party member. Class LA_PartyMember is an optional association class between LA_Party and LA_GroupParty.
See Figure 10.

The attribute of LA_PartyMember is:

- share: the fraction of the whole.

6.3.4 Code lists and enumerations for Party Package

Party Package has one enumeration class (LA_PartyType) and two code list classes (LA_PartyRoleType and LA_GroupPartyType); see Figure 10. For examples of values, see Annex J.

6.4 Classes of Administrative Package

6.4.1 LA_BAUnit

An instance of class LA_BAUnit is an basic administrative unit, and subject to registration (by law), or recordation (by informal right, or customary right, or another social tenure relationship). LA_BAUnit is associated to class LA_Party (a party may be an basic administrative unit, indicated by the attribute ‘partyType’). A basic administrative unit is associated to zero or more [0..*] spatial units.
See Figure 12.

The attributes of LA_BAUnit are:

- name: the name of the basic administrative unit
- type: the type of the basic administrative unit (e.g. basic property unit, or property right unit)
- uID: the identifier of the basic administrative unit.

NOTE 1. LA_BAUnit allows the association of one right to a combination of spatial units (e.g. an apartment and a parking place).

NOTE 2. A constraint states that, for one basic administrative unit, the sum of all the shares must be equal to 1 for the same subclass of class LA_RRR, unless ‘share’ is meaningless with regard to the type of right, restriction or responsibility. This is indicated by the ‘shareCheck’ attribute of class LA_RRR (see Clause 6.4.2).

NOTE 3. It is possible that no spatial unit exists for a basic administrative unit, thus allowing for the support of special administrative situations (e.g. deeds registration without mapping).

NOTE 4. With class LA_BAUnit it is possible to link spatial units from different levels.

In Annex C examples are presented.

6.4.2 LA_RRR

Class LA_RRR is an abstract class. An instance of a subclass of LA_RRR is a right (or social tenure relationship), a restriction, or a responsibility. If it is a right or responsibility, then it is associated to exactly one [1] party, and exactly one [1] basic administrative unit. If it is a restriction, then it is associated to zero or one [0..1] parties, and exactly one [1] basic administrative unit. The latter allows for the registration of restrictions (e.g right-of-way, right-to-harvest-fruit), with, or without an association to LA_Party. See Figure 11.

The attributes of LA_RRR are:

- description: description regarding the right, restriction or responsibility
- share: a share in an instance of a subclass of LA_RRR. There is a constraint that the sum of all shares is equal to 1. For example: two parties each holding a share of ½ in a right of ownership; or one party holding ¼ and another holding ¾ (see NOTE 2 in Clause 6.4.1 for a further explanation of the constraint)
- shareCheck: boolean indicating whether the constraint is applicable
- timeSpec: operational use of a right in time sharing. This attribute is capable of handling other temporal descriptions, such as recurring patterns (every week-end, every summer, etc.). This means, for example, that a party can hold a right to use an apartment each year in March, or that a group of pastoralists has the right to cross a field each summer (for fuzzy time range specifications see ISO 14825, Annex D).

NOTE. There is a constraint that no overlap is allowed between timeSpec’s for same RRR type and same basic administrative unit.

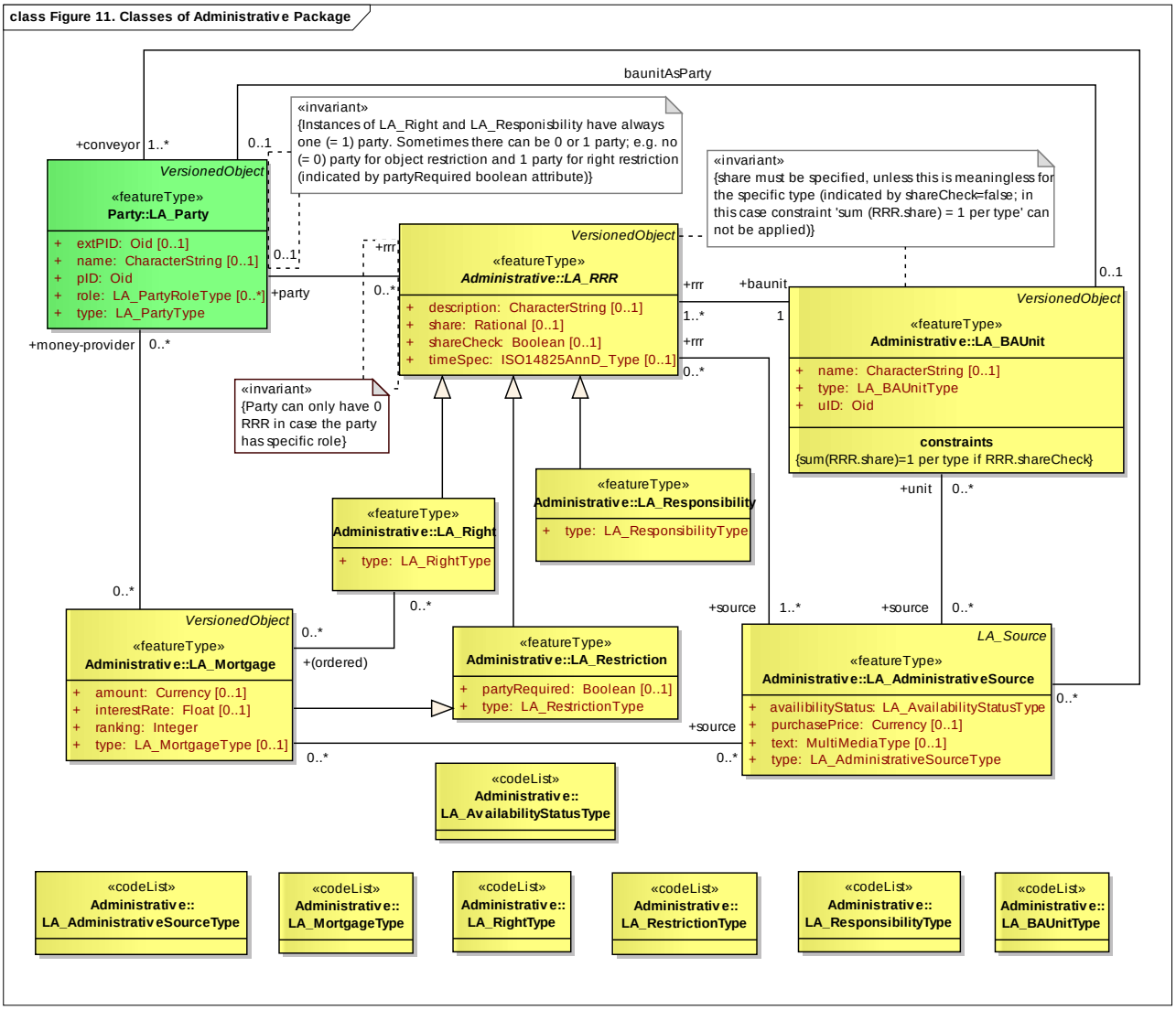


Figure 11. Content of Administrative Package and association to Party Package

6.4.3 LA_Right

An instance of class LA_Right is a right. LA_Right is a subclass of class LA_RRR. See Figure 11.

The attribute of LA_Right is:

- type: the type of the right (e.g. lease, occupation, ownership, water right, grazing right, etc.). The attribute 'type' shall be represented as an instance of class LA_RightType.

6.4.4 LA_Restriction

An instance of class LA_Restriction is a restriction. LA_Restriction is a subclass of class LA_RRR. See Figure 11.

The attributes of LA_Restriction are:

- partyRequired: indicates whether a party is required for the registration of the restriction in the association to LA_Party (if not, then it is considered to be an spatial unit restriction)

- type: the type of the restriction (e.g. a servitude, a monument, etc.). The attribute ‘type’ shall be represented as an instance of class LA_RestrictionType.

6.4.5 LA_Responsibility

An instance of class LA_Responsibility is a responsibility. LA_Responsibility is a subclass of class LA_RRR. See Figure 11.

The attribute of LA_Responsibility is:

- type: the type of the responsibility (e.g. to maintain a monument, or maintain a waterway, etc). The attribute ‘type’ shall be represented as an instance of class LA_ResponsibilityType.

6.4.6 LA_Mortgage

An instance of class LA_Mortgage is a mortgage. LA_Mortgage is a subclass of LA_Restriction. LA_Mortgage is associated to class LA_Right (the right that is the basis for the mortgage), class LA_AdministrativeSource, and class LA_Party (the party that is the money provider).
See Figure 11.

The attributes of LA_Mortgage are:

- amount: the amount of money of the mortgage. ISO 4217 shall be used for list of currencies in the ISO 19103 measure
- interestRate: interest rate of the mortgage (percentage)
- ranking: the ranking order if more than one mortgage applies to a right (or rights)
- type: the type of the mortgage. The attribute ‘type’ shall be represented as an instance of class LA_MortgageType.

6.4.7 LA_AdministrativeSource

An instance of class LA_AdministrativeSource is an administrative source. LA_AdministrativeSource is a subclass of class LA_Source.
See Figure 9 and Figure 11.

The attributes of LA_AdministrativeSource are:

- availabilityStatus: whether an administrative source is available (e.g. it may be lost by a disaster)
- purchasePrice: the purchase price in relation to a transaction (buying, selling, etc.)
- text: the content of the document. ISO/IEC 13240 Interchange Standard for Multimedia Interactive Documents (ISMID) may be used for the content
- type: the type of document (e.g. a deed, title, etc). The attribute ‘type’ shall be represented as an instance of class LA_AdministrativeSourceType.

6.4.8 Code lists for Administrative Package

Administrative Package has six code list classes (LA_AdministrativeSourceType, LA_MortgageType, LA_RightType, LA_RestrictionType, LA_ResposibilityType, and LA_BAUnitType).
See Figure 11. For examples of values, see Annex J.

6.5 Classes of Spatial Unit Package

6.5.1 LA_SpatialUnit

An instance of class LA_SpatialUnit is a spatial unit. See Figure 12.

The attributes of LA_SpatialUnit are:

- area: the area value (2D: spatial unit area). In this data type each instance has an area size and type (e.g. calculated, official, etc.)
- dimension: the dimension of the spatial unit (0D, 1D, 2D, 3D, or liminal)
- extAddressID: the link to external address(es) of the spatial unit
- label: short textual description of the spatial unit
- referencePoint: the coordinates of a point inside the spatial unit
- suID: the spatial unit identifier
- volume: the volume value (in case of bounded 3D description). In this data type, each instance has a volume size and type (e.g. calculated, official, etc.).

NOTE. The method ‘CreateArea’ returns a geometric primitive GM_MultiSurface which includes a geometric primitive GM_Surface.

6.5.2 LA_SpatialUnitGroup

An instance of class LA_SpatialUnitGroup is a spatial unit group. LA_SpatialUnitGroup is associated to class LA_SpatialUnit. See Figure 12.

The attributes of LA_SpatialUnitGroup are:

- hierarchyLevel: the level in the hierarchy of the (administrative or zoning) subdivision; highest level is 1 (country) and lower levels are incremented by 1
- label: short textual description of the spatial unit group
- name: the name of the spatial unit group
- referencePoint: the coordinates of a point within the spatial unit group
- sugID: the identifier of the spatial unit group.

6.5.3 LA_LegalSpaceBuildingUnit

An instance of class LA_LegalSpaceBuildingUnit is a building unit. LA_LegalSpaceBuildingUnit is a subclass of class LA_SpatialUnit. See Figure 12.

The attributes of LA_LegalSpaceBuildingUnit are:

- buildingUnitID: the identifier of the building unit
- type: the type of the building unit (e.g. shared, individual, etc.).

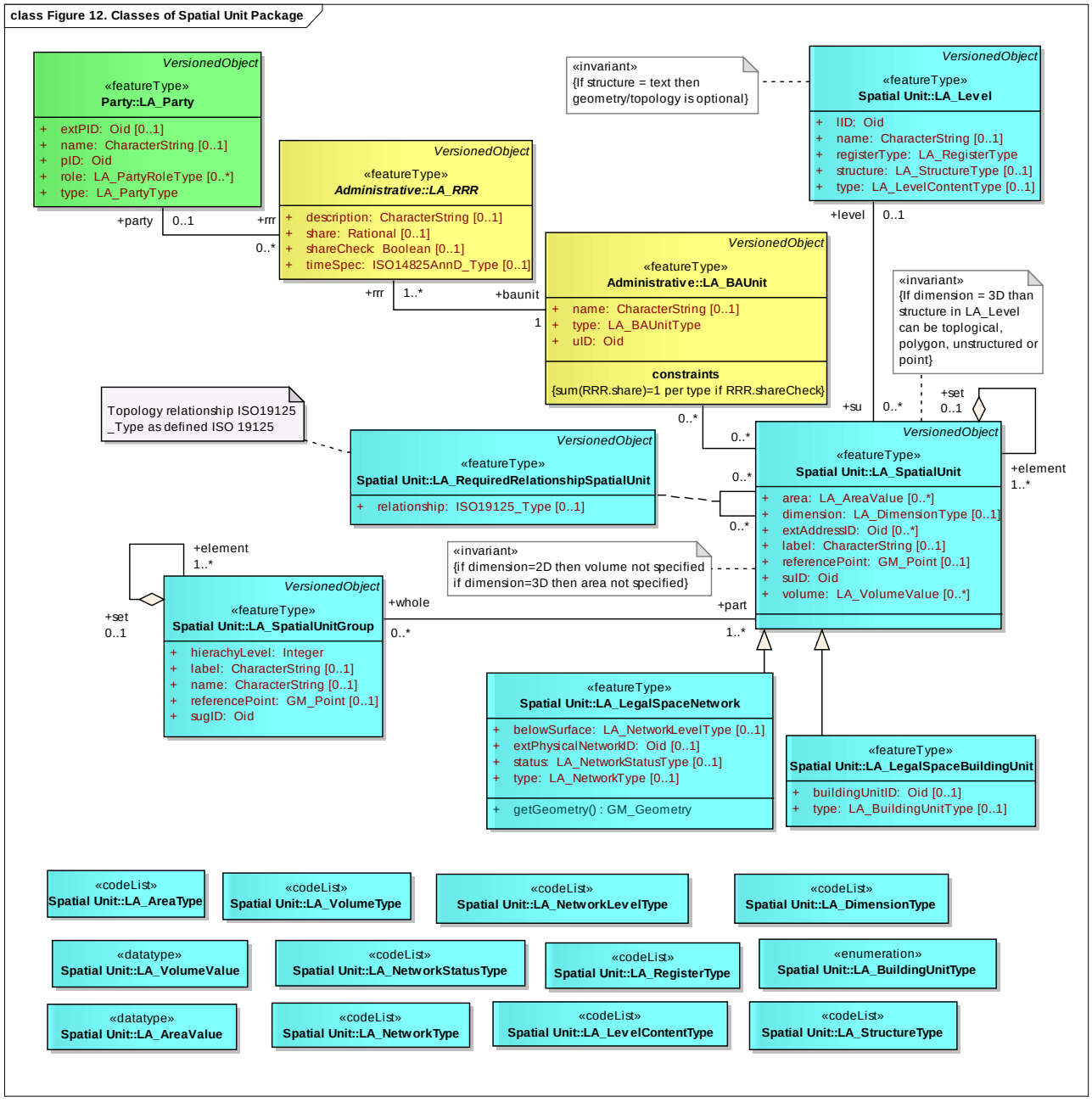


Figure 12. Content of Spatial Unit Package and main associations to classes in other packages

6.5.4 LA_LegalSpaceNetwork

An instance of LA_LegalSpaceNetwork is a network. LA_LegalSpaceNetwork is a subclass of class LA_SpatialUnit. See Figure 12.

The attributes of LA_LegalSpaceNetwork are:

- belowSurface: an underground network, or an above-the-ground network, or mixed
- extPhysicalNetworkID: a reference to the physical (technical) description of the network in an external information source (for instance, the organization responsible for the network)

- status: the status of the network (e.g. in use, planned, etc.)
- type: the type of the network (e.g. chemicals, electricity, etc.).

6.5.5 LA_Level

An instance of class LA_Level is a level. LA_Level is associated to class LA_SpatialUnit. See Figure 12.

The attributes of LA_Level are:

- lID: the identifier of the level
- name: the name of the level
- registerType: the register type of the content of the level (e.g urban, rural, forest, etc.).
- structure: the structure of the level geometry (e.g. full partition, surface, unstructured, etc.)
- type: the type of the content of the level (e.g. primary right, restriction, building, etc.).

6.5.6 LA_RequiredRelationshipSpatialUnit

An instance of association class LA_RequiredRelationshipSpatialUnit is a spatial type from ISO 19125-2 *Simple feature access Part 2: SQL option.* See Figure 12.

The attribute of LA_RequiredRelationshipSpatialUnit is:

- relationship: an ISO 19125-2 spatial type (e.g. overlaps, contains, etc.).

6.5.7 Code lists, enumerations and data types for Spatial Unit Package

Spatial Unit Package has one enumeration class (LA_BuildingUnitType), two data type classes (LA_AreaVolume and LA_VolumeValue), and nine code list classes (LA_AreaType, LA_VolumeType, LA_NetworkLevelType, LA_DimensionType, LA_NetworkStatusType, LA_RegisterType, LA_NetworkType, LA_LevelContentType, and LA_StructureType).

See Figure 12. For examples of values, see Annex J.

6.6 Classes of Surveying Subpackage

6.6.1 LA_Point

An instance of class LA_Point is a point. LA_Point is a subclass of class VersionedObject.
See Figure 13.

The attributes of LA_Point are:

- estimatedAccuracy: the estimated accuracy of the point
- interpolationRole: the role of point in the structure of a straight line or curve
- monumentation: the type of monumentation (e.g. beacon, corner stone, marker, etc.)
- originalLocation: the calculated co-ordinates, based on measurements and observations
- pID: the point identifier
- pointType: the type of point (source point, control point, etc.)
- productionMethod: lineage
- transAndResult: transformation and transformed location (ISO 19107).

6.6.2 LA_SpatialSource

An instance of class LA_SpatialSource is a spatial source. LA_SpatialSource is a subclass of class LA_Source. See Figure 9 and Figure 13.

The attributes of LA_SpatialSource are:

- measurements: the observations, and measurements, as a basis for mapping, and as a basis for historical reconstruction of the location of (parts of) the spatial unit in the field. The data type is OM_Observation and is re-used from ISO/CD 19156
- procedure: the way of surveying; of type SF_SurveyProcedure from ISO/CD 19156
- type: the type of the spatial source (e.g. field sketch, orthophoto, etc.).

NOTE. The association to LA_BAUnit is derived via intermediate classes.

6.6.3 Code lists and data types for Surveying Subpackage

Surveying Subpackage has one data type class (LA_Transformation) and four code list classes (LA_MonumentationType, LA_SpatialSourceType, LA_InterpolationType, and LA_PointType). See Figure 13. For examples of values, see Annex J.

6.7 Classes of Spatial Representation Subpackage

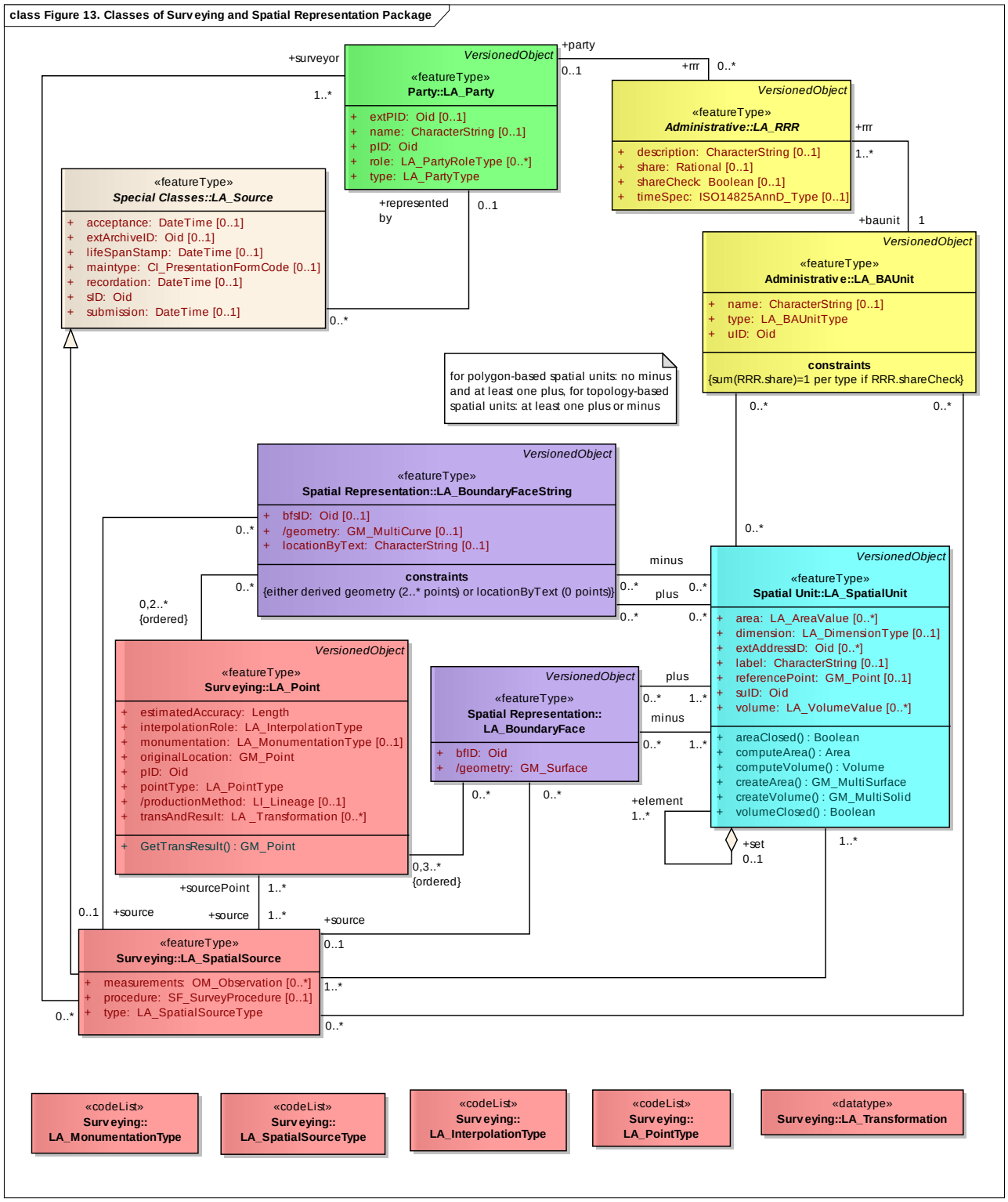


Figure 13. Contents of classes of Surveying Subpackage and Spatial Representation Subpackage with main associations

6.7.1 LA_BoundaryFaceString

An instance of class LA_BoundaryFaceString is a boundary face string. Boundary face strings are used to represent the boundaries of spatial units via linestrings in 2D (which can be projected vertically up and down to have a 3D interpretation if needed). LA_BoundaryFaceString is a subclass of class VersionedObject. It has associations with LA_Point and LA_SpatialSource to document the origin of the geometry.
See Figure 13.

The attributes of LA_BoundaryFaceString are:

- bfsID: the boundary face string identifier
- geometry: the boundary represented via a curve at ground level; can be derived from the associated class LA_Point (ISO 19107 *Spatial schema*)
- locationByText: the boundary represented in text.

6.7.2 LA_BoundaryFace

An instance of class LA_BoundaryFace is a boundary face. Boundary faces are used to represent the boundaries of spatial units via surfaces in 3D. LA_BoundaryFace is a subclass of class VersionedObject. It has associations with LA_Point and LA_SpatialSource to document the origin of the geometry.
See Figure 13.

The attributes of LA_BoundaryFace are:

- bfID: the boundary face identifier
- geometry: the boundary represented via a surface in 3D.

Annex A. Abstract Test Suite (normative)

A.1 *Introduction*

The abstract test suite is in conformance with *ISO 19105 Conformance and testing*. LADM is specifying a conceptual schema. For actual use of LADM an *application schema* has to be developed, such as a country profile. This Annex specifies how to test whether a specific application schema (or, country profile) is for which package and up to what level LADM conformant. Testing whether a specific *data set* is conformant, means checking the data set content against the corresponding conformant LADM application schema (package and level).

This test suite specifies the requirements that an implementation under test has to meet in order to be conformant to this International Standard. For each test the metadata conformity element takes one of the following values:

1. Conformant (conformant). The resource is fully conformant with the cited specification.
2. Not Conformant (notConformant). The resource does not conform to the cited specification.
3. Not evaluated (notEvaluated). Conformance has not been evaluated.

The LADM consists of three packages and two subpackages, and for each of them a conformance test is specified. Three conformance levels are specified per (sub)package: level 1 (low level, mandatory), level 2 (medium level, optional), and level 3 (high level, optional). Level 1 tests the mandatory classes per package and level 2 also includes the more common optional classes. Level 3 includes all classes.

Table A1 gives an overview of the mandatory and optional classes per package to check for LADM compliancy. LADM can be implemented per package, but there are interdependencies. The mandatory and optional attributes are given in the class diagrams. The same holds for associations (also in case of interdependencies).

The test method in this Annex is in all test cases ‘to examine the application schema of implementation under test, including class, attribute(s) and association definitions.’ There are a number of different ways to document the positive results of the test method:

1. Show inheritance structure between LADM and the tested model (elements), or
2. Show mapping of elements between LADM and the tested model.

The test has besides the positive (confirming) side, documented per class in the sections below, also a negative side: the application schema (model) should not include different structures/solutions, when LADM has a standard provision. This is the last test of a package.

LADM package	***LADM class***	***Conformance level:*** ***O = Optional*** ***M = Mandatory***	***Dependencies***
Party Package		O	Exist only if Administrative Package is implemented
	LA_Party	M, 1	
	LA_GroupParty	O, 2	
	LA_PartyMember	O, 2	

LADM package	***LADM class***	***Conformance level:*** ***O = Optional*** ***M = Mandatory***	***Dependencies***
Administrative Package		O	Exist only if Party Package is implemented
	LA_RRR	M, 1	NOTE: abstract
	LA_Right	M, 1	
	LA_Restriction	O, 2	
	LA_Responsibility	O, 3	
	LA_BAUnit	M, 1	
	LA_Mortgage	O, 2	
	LA_AdministrativeSource	O, 2	
Spatial Unit Package		O	
	LA_SpatialUnit	M, 1	
	LA_SpatialUnitGroup	O, 2	
	LA_LegalSpaceBuildingUnit	O, 3	
	LA_LegalSpaceNetwork	O, 3	
	LA_Level	O, 2	
	LA_RequiredRelationshipSpatialUnit	O, 3	
Surveying Subpackage		O	
	LA_Point	M, 2	
	LA_SpatialSource	M, 2	
Spatial Representation Subpackage		O	
	LA_BoundaryFaceString	M, 2	
	LA_BoundaryFace	O, 3	

Table A1. LADM conformance requirements table

A.2 *Abstract test suite for conformance level 1 (low level)*

This test suite tests the following requirement: the implementation of the package under test shall contain at least the mandatory class(es) of LADM. These classes of LADM are: LA_BAUnit, LA_Right, LA_Party and LA_SpatialUnit. Implementation class shall conform to mandatory class. This means that a LADM package is level 1 compliant if:

- Party package: test A.2.2 is passed successfully

- Administrative package: test A.2.1 and test A.2.3 are passed successfully (note in models where there is a 1-to-1 association between LA_Right and LA_BAUnit these may both be represented by the same implementation class)
- Spatial Unit package: test A.2.4 is passed successfully.

A.2.1 Test case identifier: Administrative::LA_BAUnit

a. Test Purpose: to ensure that the implementation package under test contains at least one class conformant with definition of LA_BAUnit and which has all mandatory attributes and association roles of LA_BAUnit. NOTE. Mandatory attributes or associations have occurrence (multiplicity) 1 or higher

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 1 requirement, Clause 4.1.2, and Clause 6.4.1

d. Test Type: Basic.

A.2.2 Test case identifier: Party::LA_Party

a. Test Purpose: to ensure that the implementation package under test contains at least one class conformant with definition of LA_Party and has all mandatory attributes and association roles of LA_Party

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 1 requirement, Clause 4.1.12, and Clause 6.3.1

d. Test Type: Basic.

A.2.3 Test case identifier: Administrative::LA_Right

c. Test Purpose: to ensure that the implementation package under test contains at least one class conformant with definition of one of the specializations of class LA_Right and has all mandatory attributes and association roles of LA_Right.

d. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

e. Reference: level 1 requirement, Clause 4.1.19, and Clause 6.4.2 and Clause 6.4.3

f. Test Type: Basic.

A.2.4 Test case identifier: Spatial Unit::LA_SpatialUnit

a. Test Purpose: to ensure that the implementation package under test contains at least one class conformant with definition of LA_SpatialUnit and has all mandatory attributes and association roles roles of LA_SpatialUnit.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 1 requirement, Clause 4.1.22, and Clause 6.5.1

d. Test Type: Basic.

A.3 *Abstract test suite for conformance level 2 (medium level)*

This test suite tests the following requirement: the implementation of the package under test shall contain at least the mandatory class(es) and the more common optional classes of LADM. These classes of LADM

are, in addition to the mandatory classes (level 1): LA_AdministrativeSource, LA_BoundaryFaceString, LA_GroupParty, LA_PartyMember, LA_Point, LA_Restriction, LA_SpatialSource, and LA_SpatialUnitGroup. Implementation class shall conform to mandatory/common optional class. This means that a LADM (sub)package is level 2 compliant if it is level 1 compliant and:

- Party package: test A.3.3 and test A.3.4 are passed successfully
- Administrative package: test A.3.1 and test A.3.6 are passed successfully
- Spatial Unit package: test A.3.8 is passed successfully
    - Spatial Representation subpackage: test A.3.2 is passed successfully
    - Surveying subpackage: test A.3.5 and test A.3.7 are passed successfully.

A.3.1 Test case identifier: Administrative::LA_AdminstrativeSource

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_AdminstrativeSource and which has all mandatory attributes and association roles of LA_AdminstrativeSource.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions.

c. Reference: level 2 requirement, Clause 4.1.1, Clause 4.1.20, Clause 6.2.2, and Clause 6.4.7

d. Test Type: Basic.

A.3.2 Test case identifier: Spatial Representation:: LA_BoundaryFaceString

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_BoundaryFaceString and has all mandatory attributes and association roles of LA_BoundaryFaceString

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.4, and Clause 6.7.1

d. Test Type: Basic.

A.3.3 Test case identifier: Party:: LA_GroupParty

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of one of the specializations of class LA_GroupParty and has all mandatory attributes and association roles of LA_GroupParty.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.7 and Clause 6.3.2

d. Test Type: Basic.

A.3.4 Test case identifier: Party::LA_PartyMember

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_PartyMember and has all attributes and association roles of LA_PartyMember.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.13, and Clause 6.3.3

d. Test Type: Basic.

A.3.5 Test case identifier: Surveying::LA_Point

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_Point and which has all mandatory attributes and association roles of LA_Point.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions.

c. Reference: level 2 requirement, Clause 4.1.14, and Clause 6.6.1

d. Test Type: Basic.

A.3.6 Test case identifier: Administrative::LA_Restriction

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_Restriction and has all mandatory attributes and association roles of LA_Restriction

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.18, and Clause 6.4.4

d. Test Type: Basic.

A.3.7 Test case identifier: Surveying::LA_SpatialSource

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of one of the specializations of class LA_SpatialSource and has all mandatory attributes and association roles of LA_SpatialSource.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.1, Clause 4.1.21, and Clauses 6.2.2.

d. Test Type: Basic.

A.3.8 Test case identifier: Spatial Unit::LA_SpatialUnitGroup

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_SpatialUnitGroup and has all attributes and association roles of LA_SpatialUnitGroup.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 2 requirement, Clause 4.1.23, and Clause 6.5.2

d. Test Type: Basic.

A.4 *Abstract test suite for conformance level 3 (high level)*

This test suite tests the following requirement: the implementation of the package under test shall contain the mandatory class(es) and all the optional class(es) of LADM. These classes of LADM are, in addition to the mandatory and common optional classes (level 1 and 2): LA_BoundaryFace, LA_LegalSpaceBuildingUnit, LA_LegalSpaceNetwork, LA_Mortgage, LA_RequiredRelationshipSpatialUnit, and LA_Responsibility. Implementation class shall conform to mandatory/common optional class. This means that a LADM (sub)package is level 3 compliant if it is level 2 compliant and:

- Administrative package: test A.4.4 and test A.4.6 are passed successfully

- Spatial Unit package: test A.4.2, test A.4.3 and test A.4.5 are passed successfully
    - Spatial Representation subpackage: test A.4.1 is passed successfully

A.4.1 Test case identifier: Spatial Representation::LA_BoundaryFace

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_BoundaryFace and has all mandatory attributes and association roles of LA_BoundaryFace

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 4.1.3, and Clause 6.7.2

d. Test Type: Basic.

A.4.2 Test case identifier: Spatial Unit::LA_LegalSpaceBuildingUnit

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of one of the specializations of class LA_LegalSpaceBuildingUnit and has all mandatory attributes and association roles of LA_LegalSpaceBuildingUnit.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 4.1.5, and Clause 6.5.3

d. Test Type: Basic.

A.4.3 Test case identifier: Spatial Unit::LA_LegalSpaceNetwork

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_LegalSpaceNetwork and has all attributes and association roles of LA_LegalSpaceNetwork.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 4.1.11, and Clause 6.5.4

d. Test Type: Basic.

A.4.4 Test case identifier: Administrative::LA_Mortgage

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_Mortgage and has all mandatory attributes and association roles of LA_Mortgage

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 6.4.6

d. Test Type: Basic.

A.4.5 Test case identifier: Spatial Unit::LA_RequiredRelationshipSpatialUnit

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of one of the specializations of class LA_RequiredRelationshipSpatialUnit and has all mandatory attributes and association roles of LA_RequiredRelationshipSpatialUnit.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 4.1.16, and Clause 6.5.6

d. Test Type: Basic.

A.4.6 Test case identifier: Administrative::LA_Responsibility

a. Test Purpose: to ensure that the implementation under test contains at least one class conformant with definition of LA_Responsibility and has all attributes and roles of LA_Responsibility.

b. Test Method: examine the application schema of implementation under test, including class, attribute(s) and association definitions

c. Reference: level 3 requirement, Clause 4.1.17, and Clause 6.4.5

d. Test Type: Basic.

Annex B. STDM (informative)

The Social Tenure Domain Model (STDM) is an initiative of UN-HABITAT to support pro-poor land administration (UN-HABITAT, 2009). STDM is meant specifically for developing countries, countries with very little cadastral coverage in urban, or rural areas. It is also meant for post conflict areas, areas with large scale informal settlements, or large scale customary areas. The focus of STDM has been on the relationships between people and land, independently from the level of formalization, or legality of those relationships. It is a search for a model that should support all forms of land rights, social tenure relations, and overlapping claims to land (Van Oosterom et al, 2005; Augustinus, 2006).

LADM class name	*STDM alias*
AdministrativeSource	SocialTenureInventory
LegalSpaceBuildingUnit	Unit
BoundaryFace	*similar name*
BoundaryFaceString	*similar name*
GroupParty	*similar name*
BAUnit	*similar name*
Level	*similar name*
Mortgage	Collateral
LegalSpaceNetwork	UtilityNetwork
Party	*similar name*
PartyMember	*similar name*
Responsibility	*similar name*
Restriction	*similar name*
RequiredRelationshipSpatialUnit	*similar name*
Right	STDM_Relationship
RRR	SocialTenureRelationship
Source	*similar name*
Point	SurveyPoint
SpatialSource	SpatialUnitInventory
SpatialUnit	*similar name*
SpatialUnitGroup	AdminSpatialUnit
VersionedObject	*similar name*

Table B1. LADM class names with their aliases in STDM

LADM originated from areas with formal cadastre and land registry systems. It should be observed that STDM contains the functionality of LADM, but under different terminology. Formal terminology as used in LADM may not always be applicable because of the informal environment. In STDM the same classes as in LADM are used, but sometimes under different terminology: e.g. class RRR is named class SocialTenureRelationship (see Table B1).

Annex C. Instance Level Cases (informative)

Note that the content of this Annex is based on:

ISO 19109:2005, *Geographic Information – Rules for Application Schemas*

ISO 19110:2005, *Geographic Information – Methodology for Feature Cataloguing*

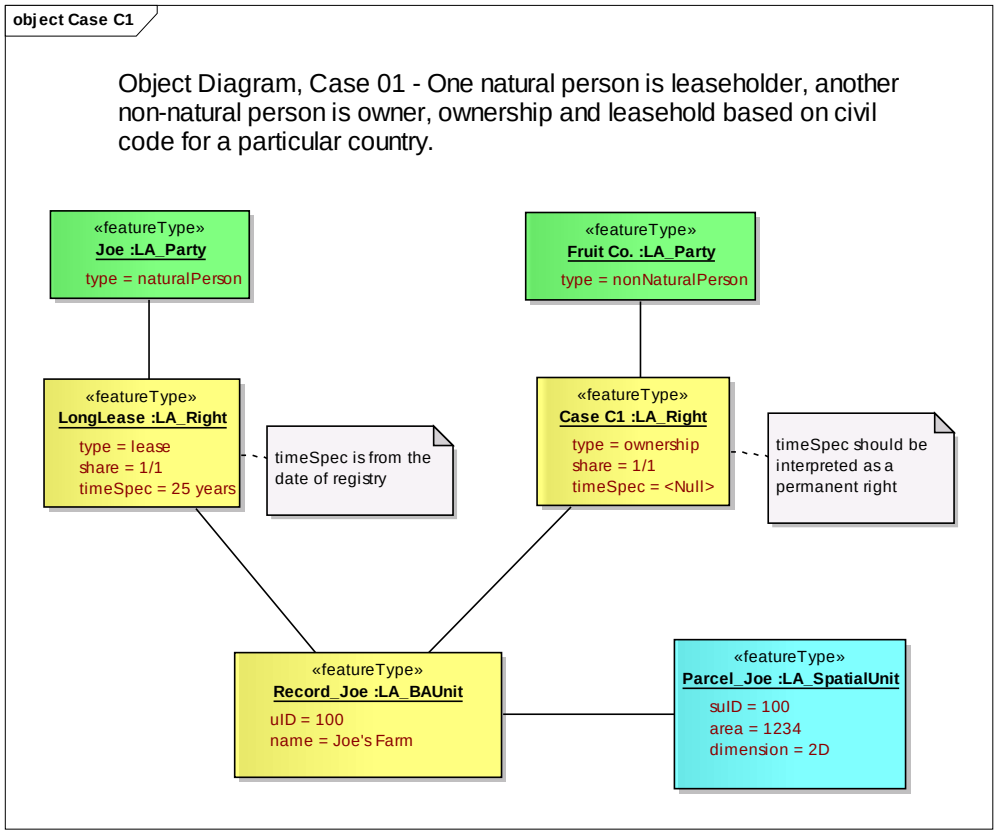
ISO 19126:2009, *Geographic Information – Feature Concept Dictionaries and Registers*

ISO 19131:2007, *Geographic Information – Data Product Specification*

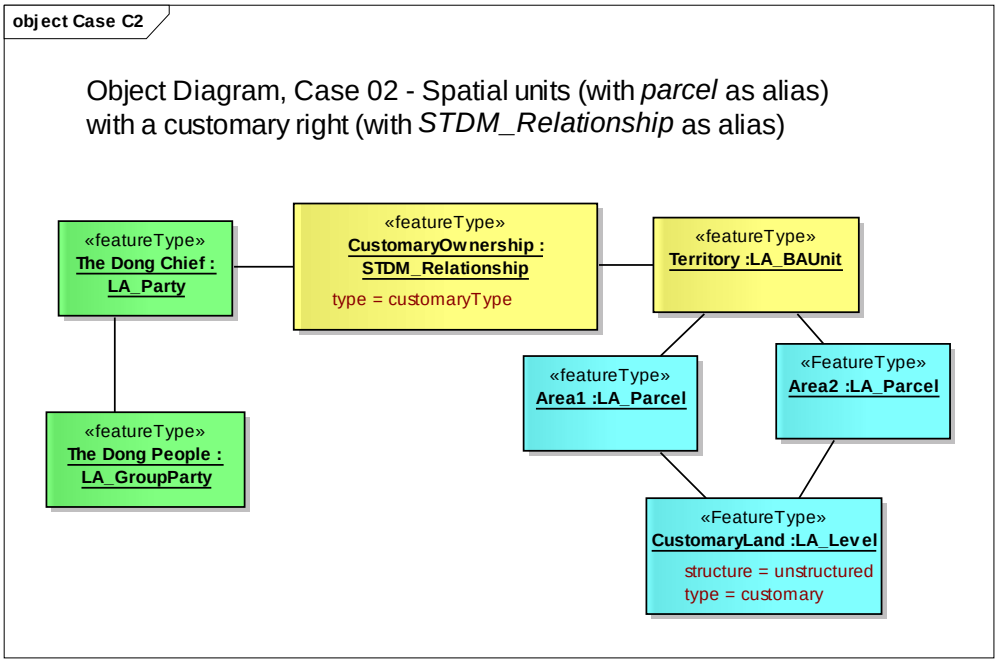
The examples are partly based on the terminology of STDM (Annex B) to illustrate the context of STDM.

1. A natural person is leaseholder, and a non-natural person is owner; ownership and leasehold based on civil code for a particular country (Case C1).
2. Spatial units with a customary right (Case C2).
3. A serving parcel provides access to four parcels, and the serving parcel is not public, but commonly owned by four neighbouring parcels (Case C3) .
4. A serving parcel provides access to four parcels, and the serving parcel is not public, but owned by a fifth party. The four neighbouring parcels have right-of-way (Case C4).
5. A group party holds a ownership right on a parcel (Case C5).
6. A building contains individual units (apartments), and a shared unit, with a common threshold (entrance) on ground level (Case C6).
7. A 3D volume spatial unit with one owner (Case C7).
8. A timeshare ownership for the month of February (Case C8).
9. A restriction not to change a building because of its monumental status (Case C9).
10. Mortgage on ownership, bank included as party (Case C10).
11. Mortgage on usufruct of ownership, money provider included as party (Case C11).
12. Informal right by a party (natural person) on a text spatial unit (Case C12).
13. Informal right by a group party on a point spatial unit (Case C13).
14. A conflicting claim on a spatial unit (Case C14).
15. A utility network with one owner and a mortgage (bank included as party) (Case C15).
16. A group party (pastoralists) with an access right for a certain period of time (Case C16).
17. A farmer owning several spatial units in rural area; example Finland (Case C17).
18. Value as basis for taxation valid for five years (Case C18).
19. A milk right to a spatial unit (Case 19).
20. A responsibility to clean the ditches (Case C20).
21. A right to use a road on a property of somebody else I (Case C21).
22. A right to use a road on a property of somebody else II (Case C22).
23. A restriction area (“it is not allowed to built within 200 metres of a fuel station”) with its own geometry (Case C23).
24. Spatial unit complex with one owner (Case C24).

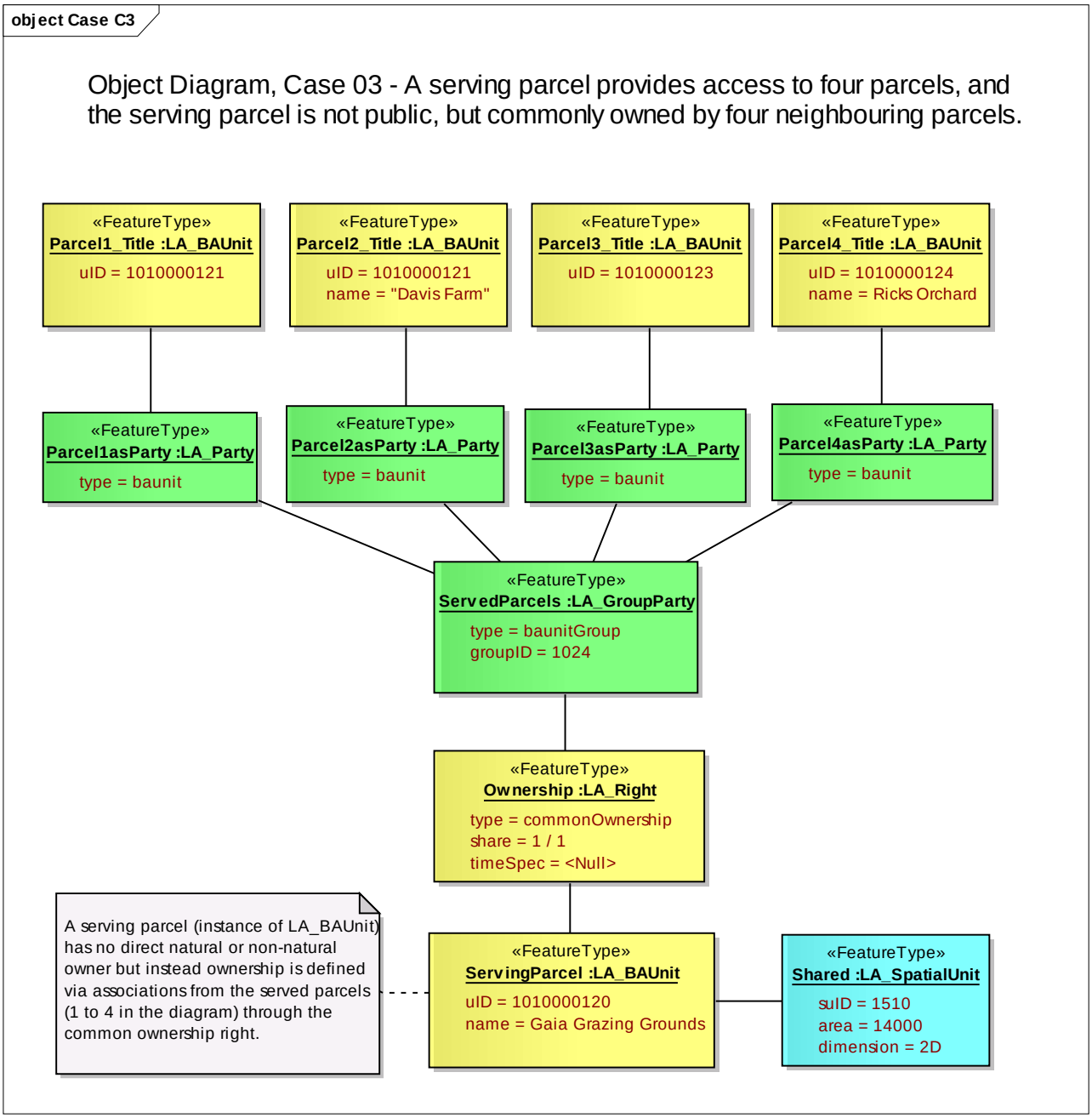
25. Spatial unit complex with building, one owner (Case 25).
26. Complex of parcels with two owners (Case C26).
27. Spatial unit with micro credit (Case C27).
28. Tax valuations on condominium rights in Spain (Case C28).
29. A spatial unit with one owner, with a building from a different owner (Case C29).
30. Marriage and inheritance relationships to property (simple) in Spain (Case C30).
31. Marriage and inheritance relationships to property (complex) in Spain (Case C31).
32. Spanish 'real estate' form of property (Case C32).
33. Norwegian categories of basic properties I (Case C33).
34. Norwegian categories of basic properties II (Case C34)
35. Individual and joint property rights in Spain (Case C35).



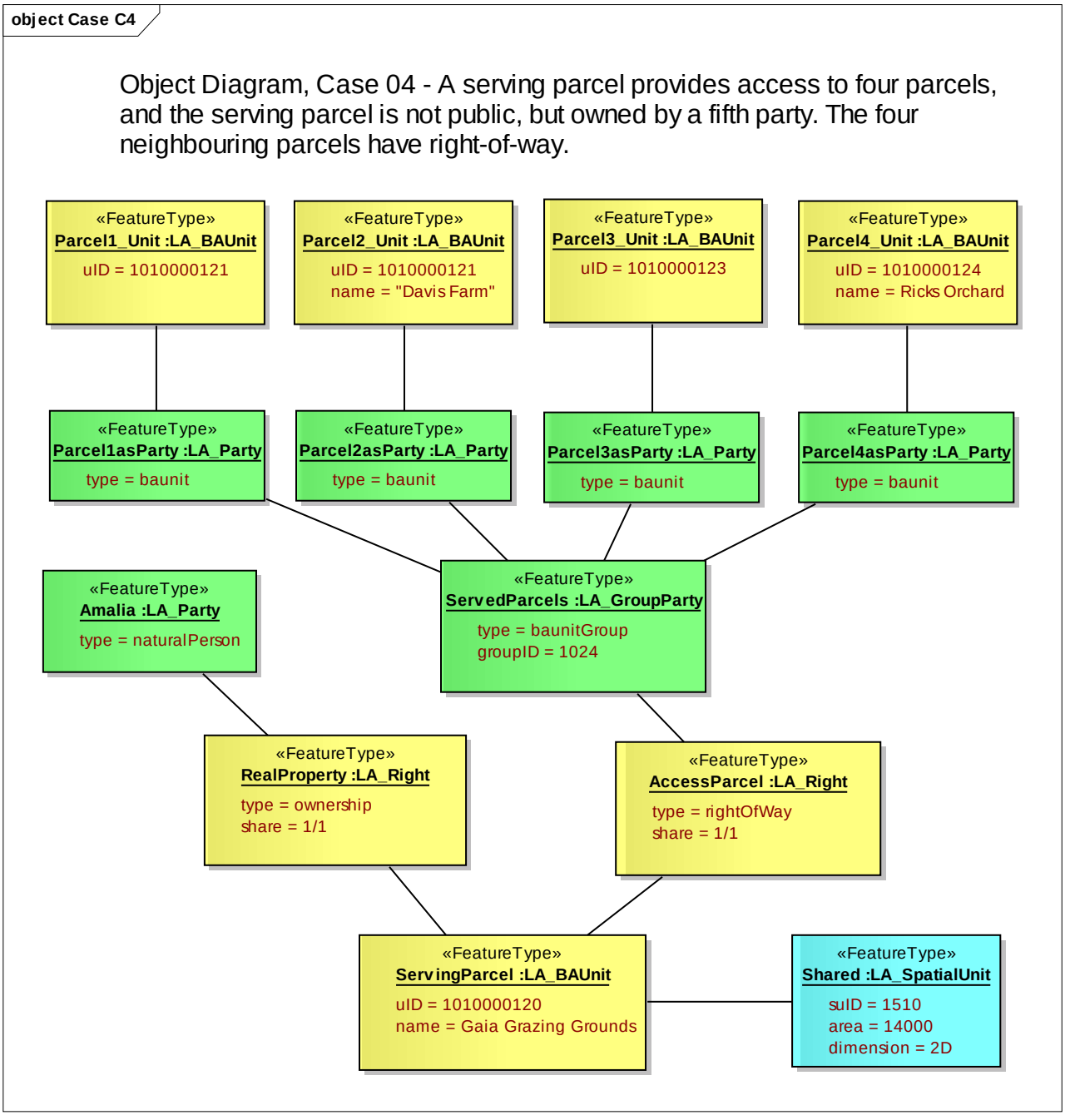
Case C1. A natural person is leaseholder, and a non-natural person is owner; ownership and leasehold based on civil code for a particular country



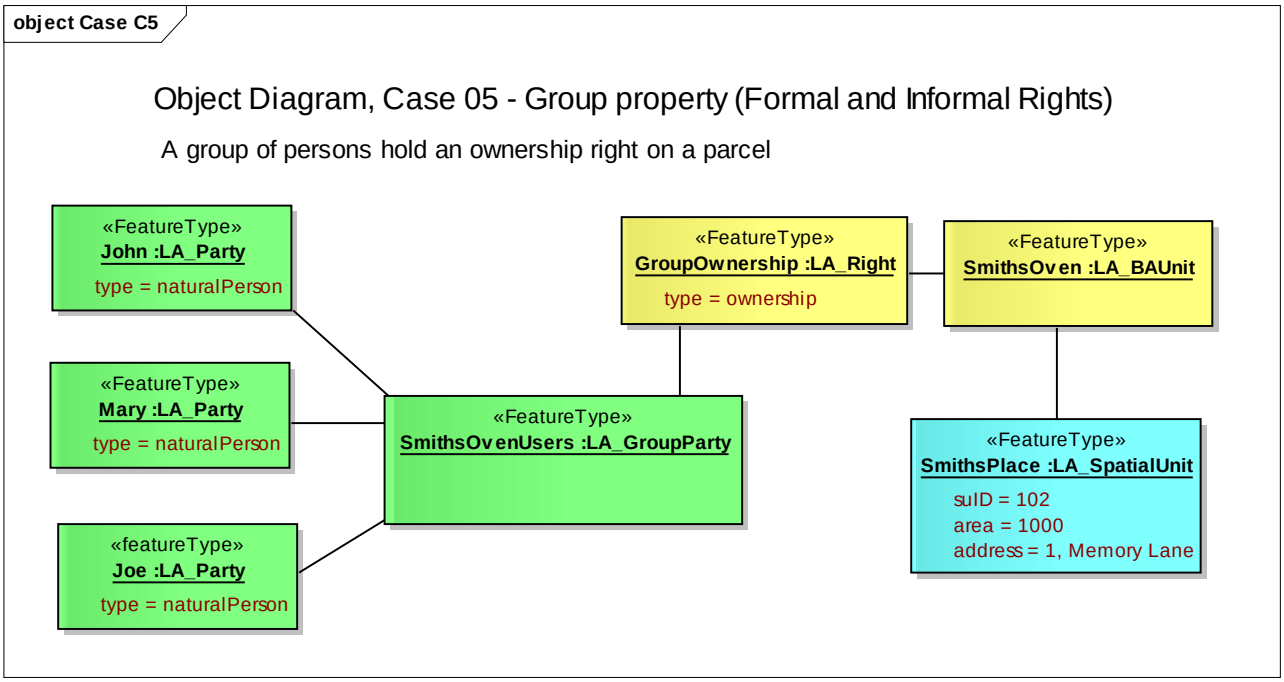
Case C2. Spatial units with a customary right



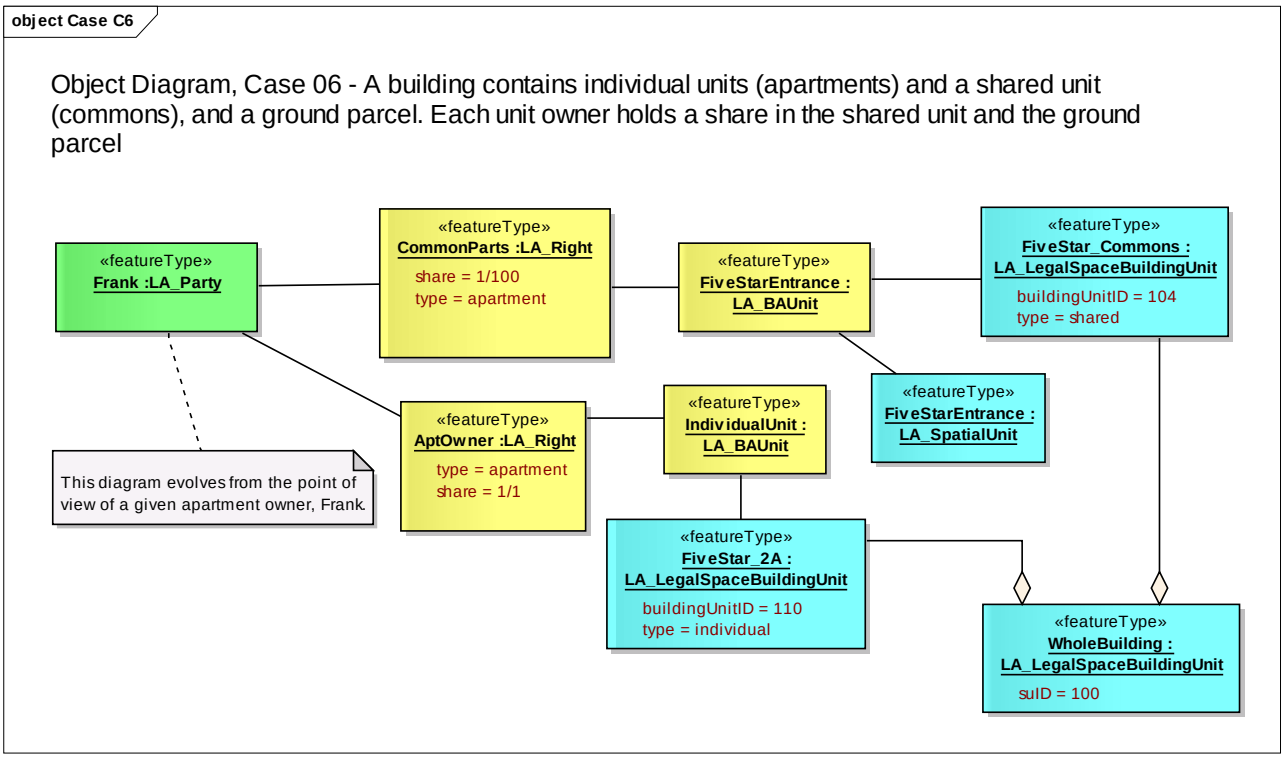
Case C3. A serving parcel provides access to four parcels, and the serving parcel is not public, but commonly owned by four neighbouring parcels



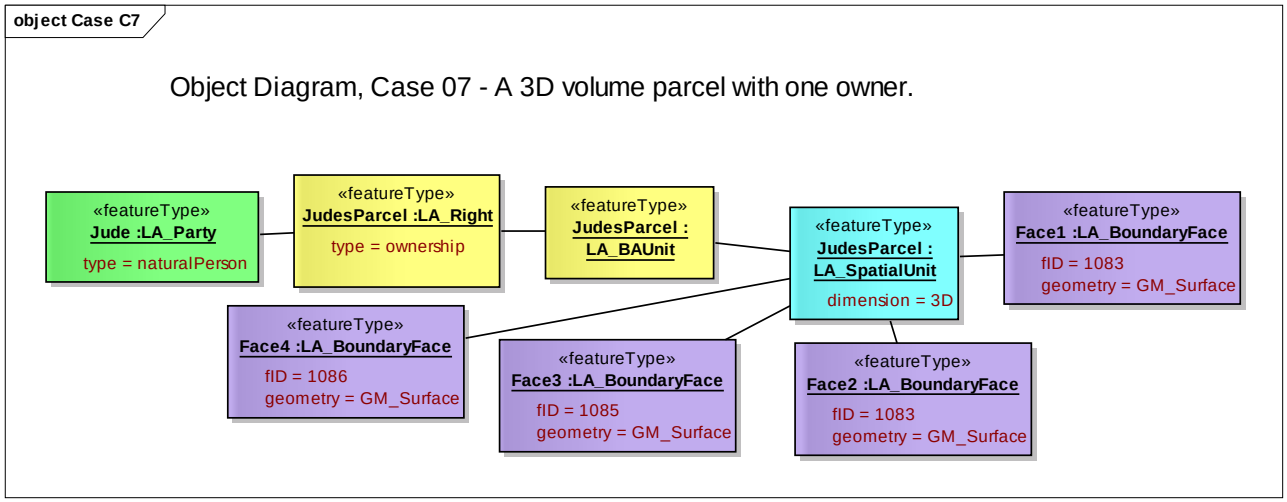
Case C4. A serving parcel provides access to four parcels, and the serving parcel is not public, but owned by a fifth party. The four neighbouring parcels have right-of-way



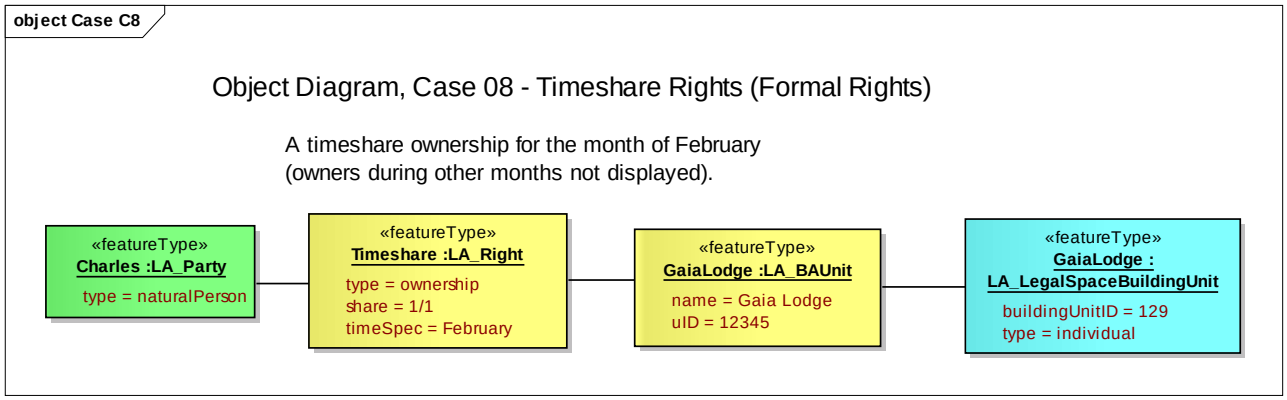
Case C5. A group party holds a ownership right on a parcel



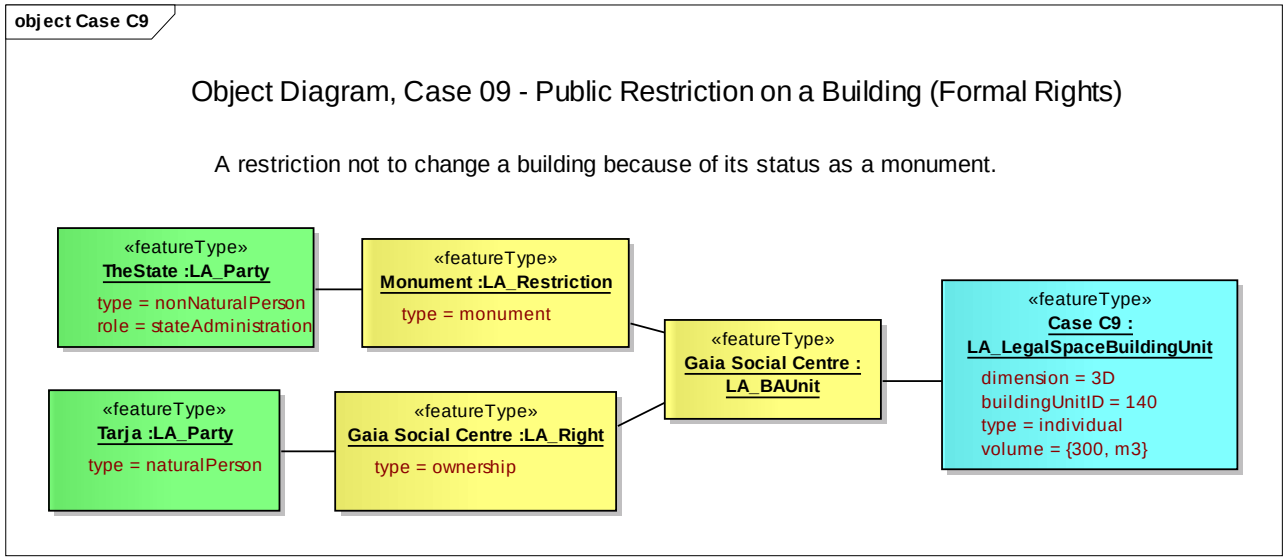
Case C6. A building contains individual units (apartments), and a shared unit, with a common threshold (entrance) on ground level



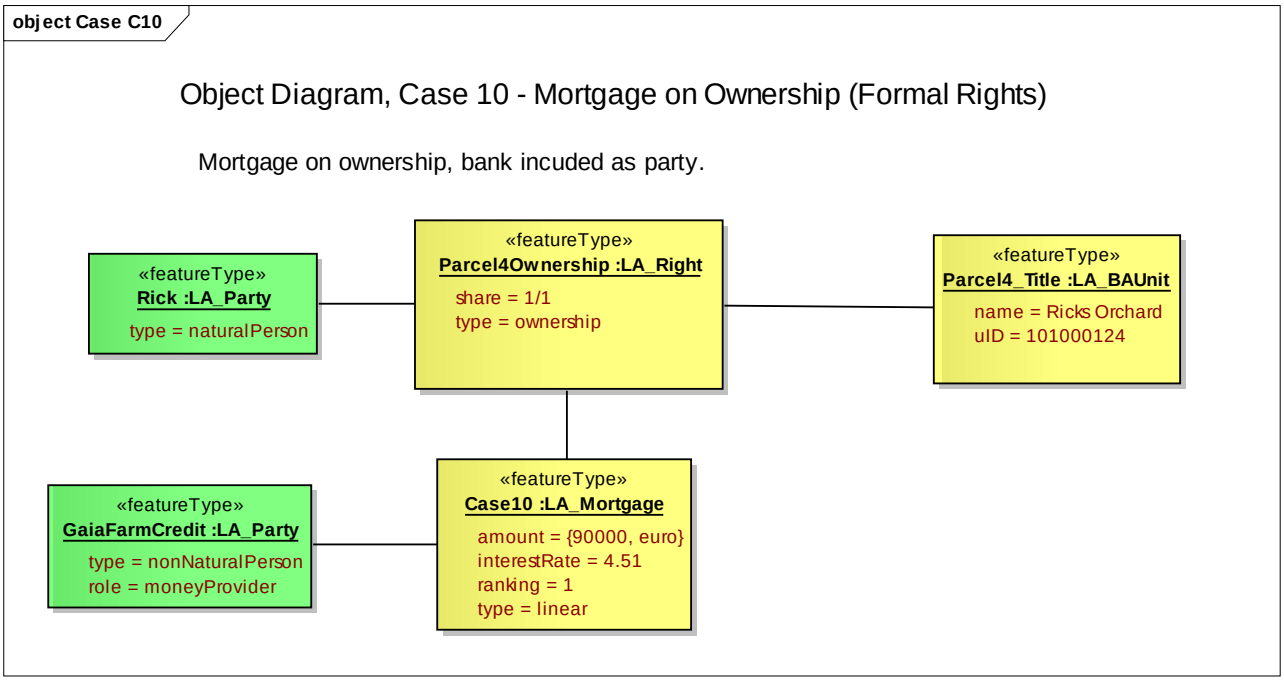
Case C7. A 3D volume spatial unit with one owner



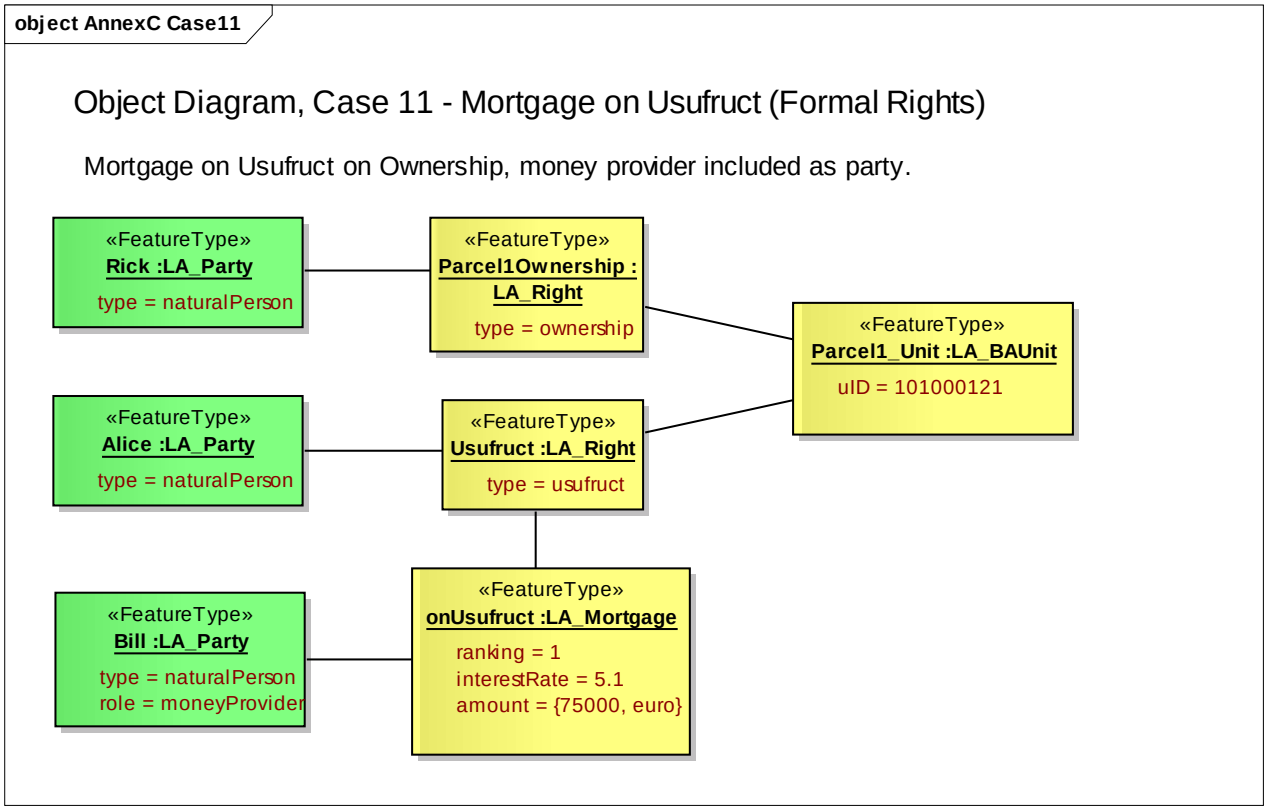
Case C8. A timeshare ownership for the month of February



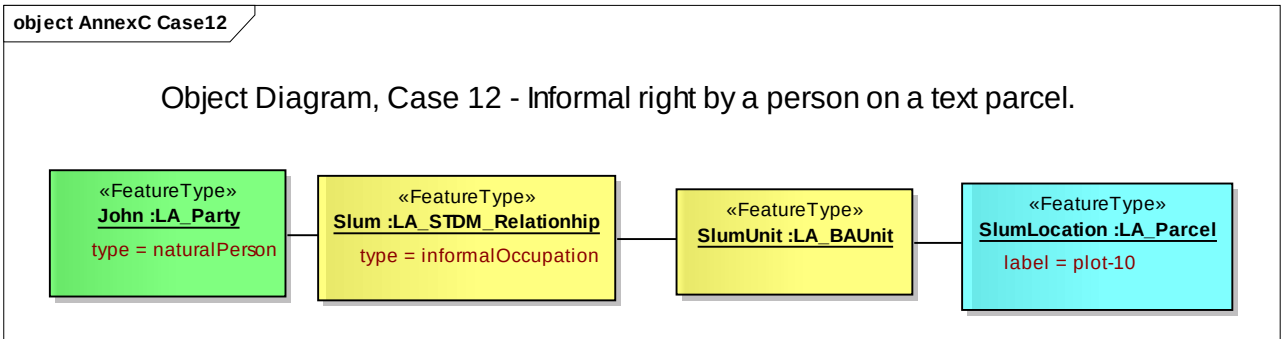
Case C9. A restriction not to change a building because of its monumental status



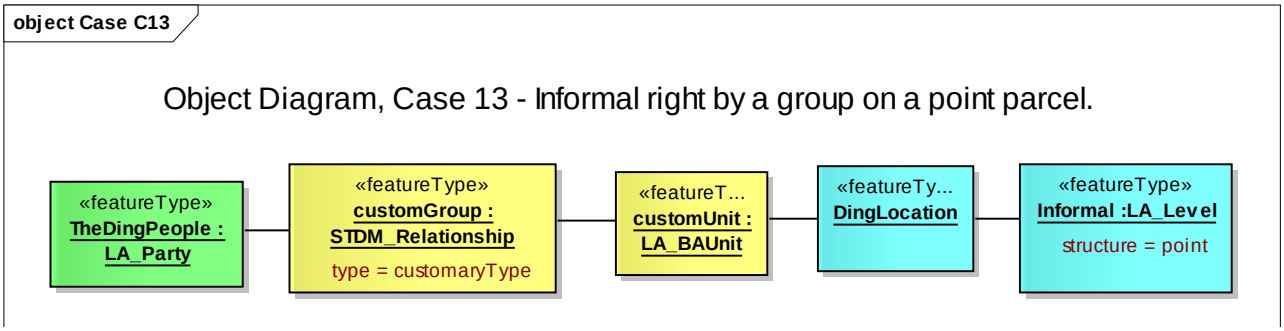
Case C10. Mortgage on ownership, bank included as party



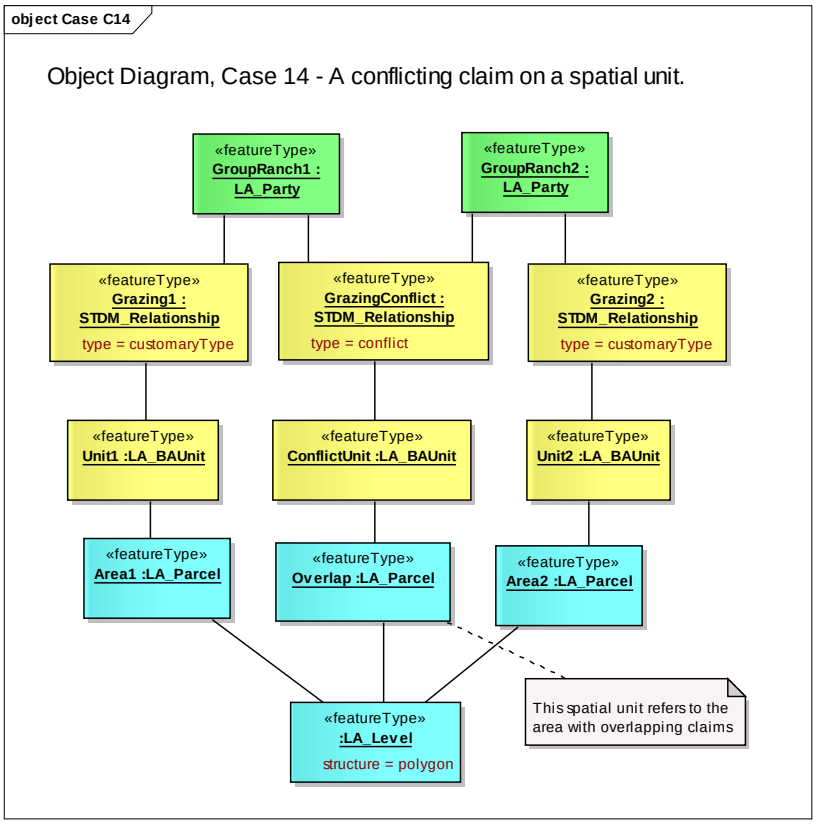
Case C11. Mortgage on usufruct of ownership, money provider included as party



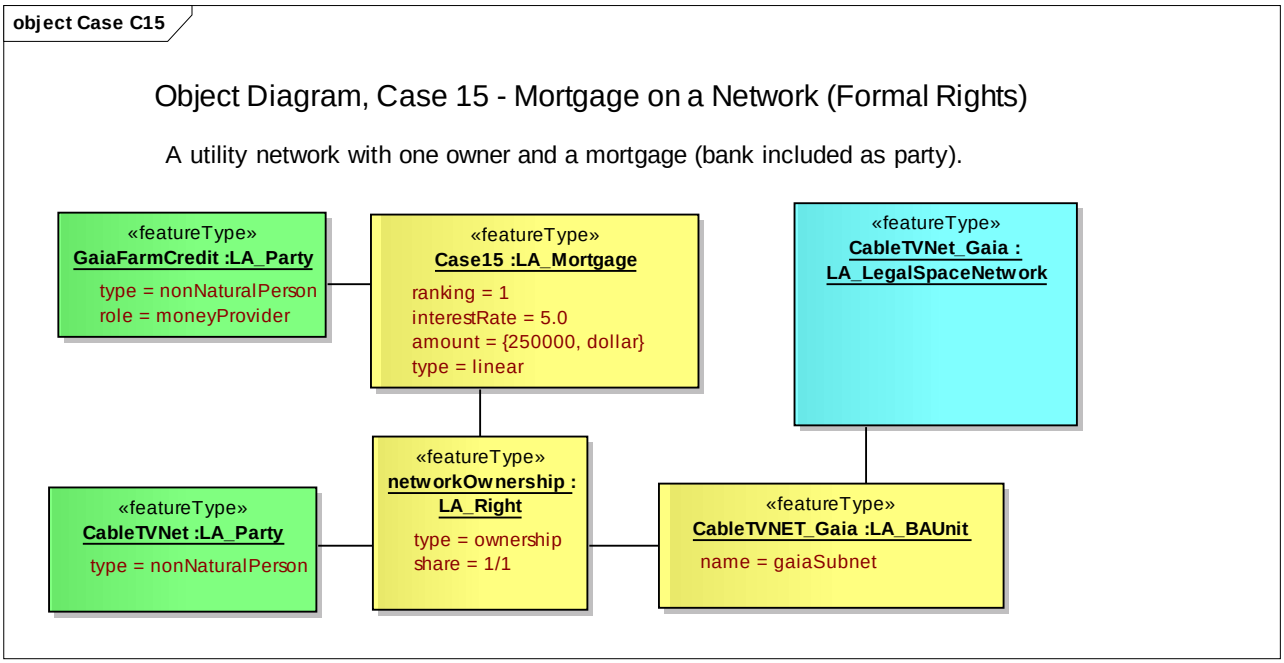
Case C12. Informal right by a party (natural person) on a text spatial unit



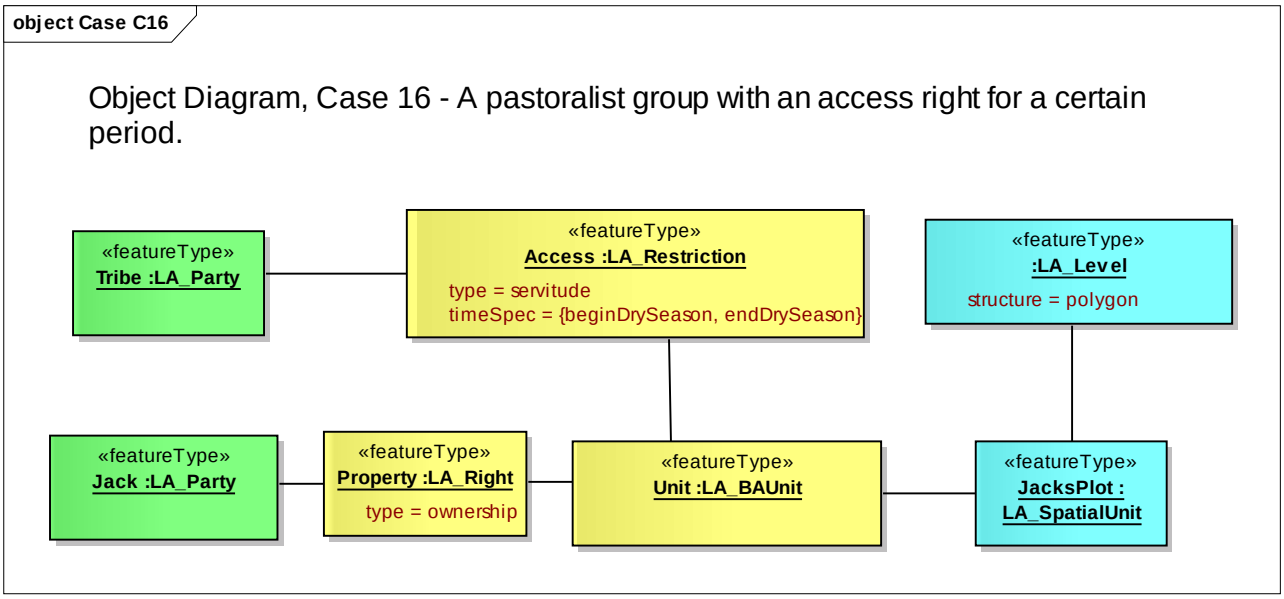
Case C13. Informal right by a group party on a point spatial unit



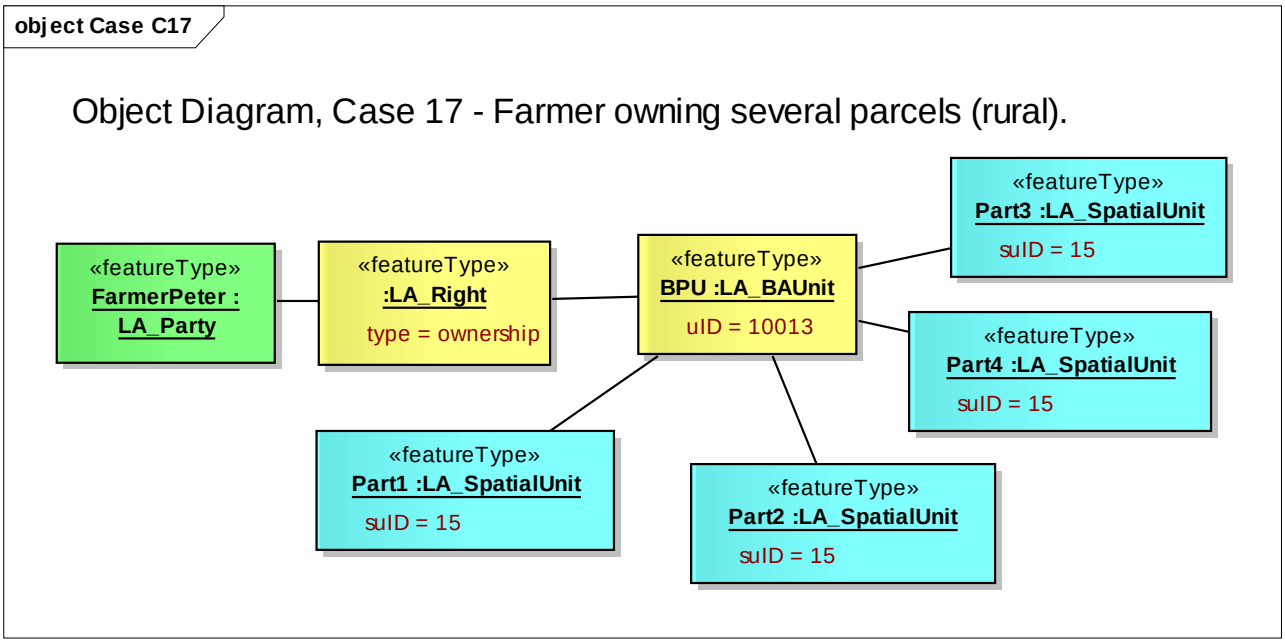
Case C14. A conflicting claim on a spatial unit



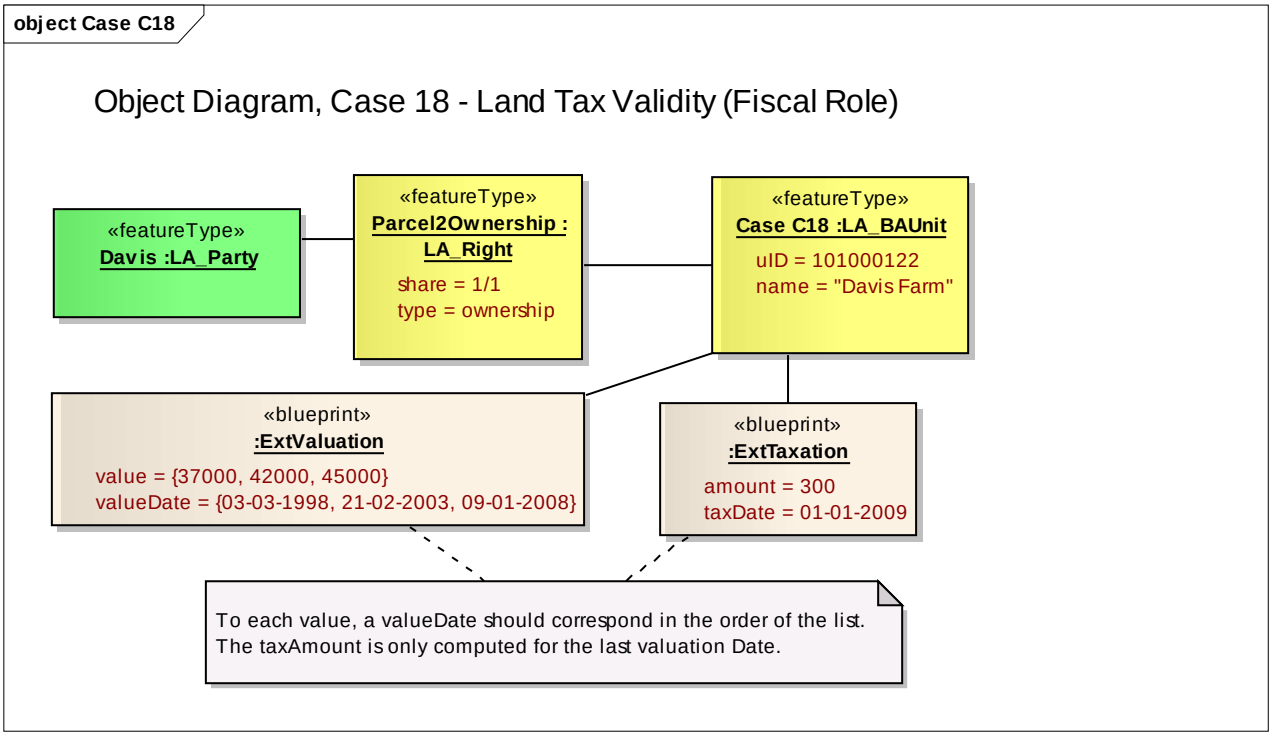
Case C15. A network with one owner and a mortgage (bank included as party)



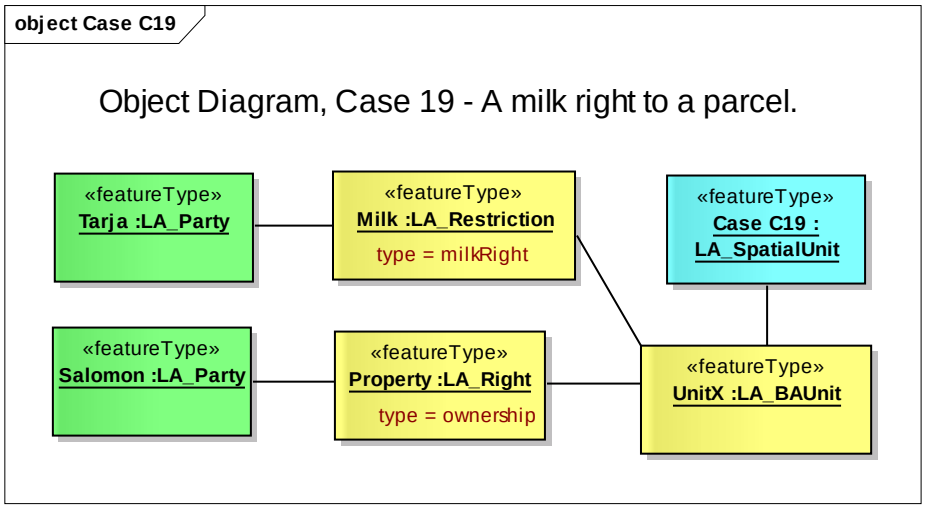
Case C16. A group party (pastoralists) with an access right for a certain period of time



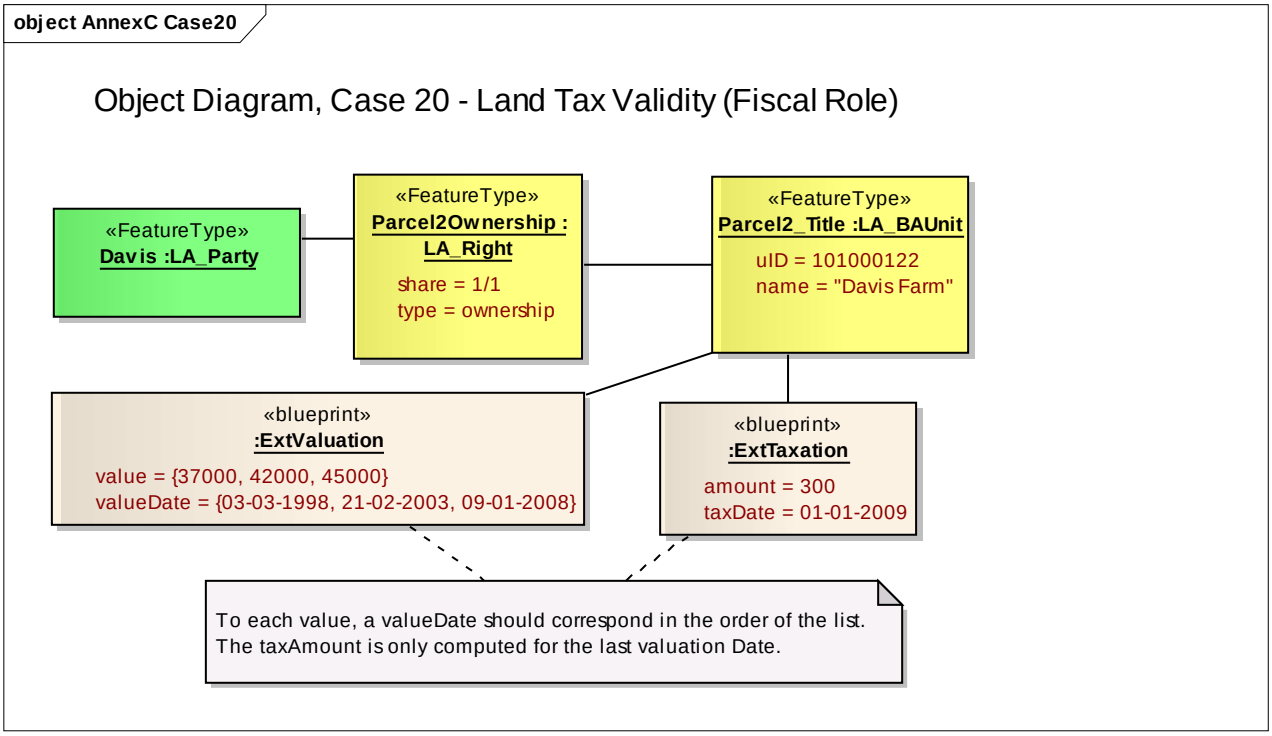
Case C17. A farmer owning several spatial units in rural area; basic property unit = 15 (example from Finland)



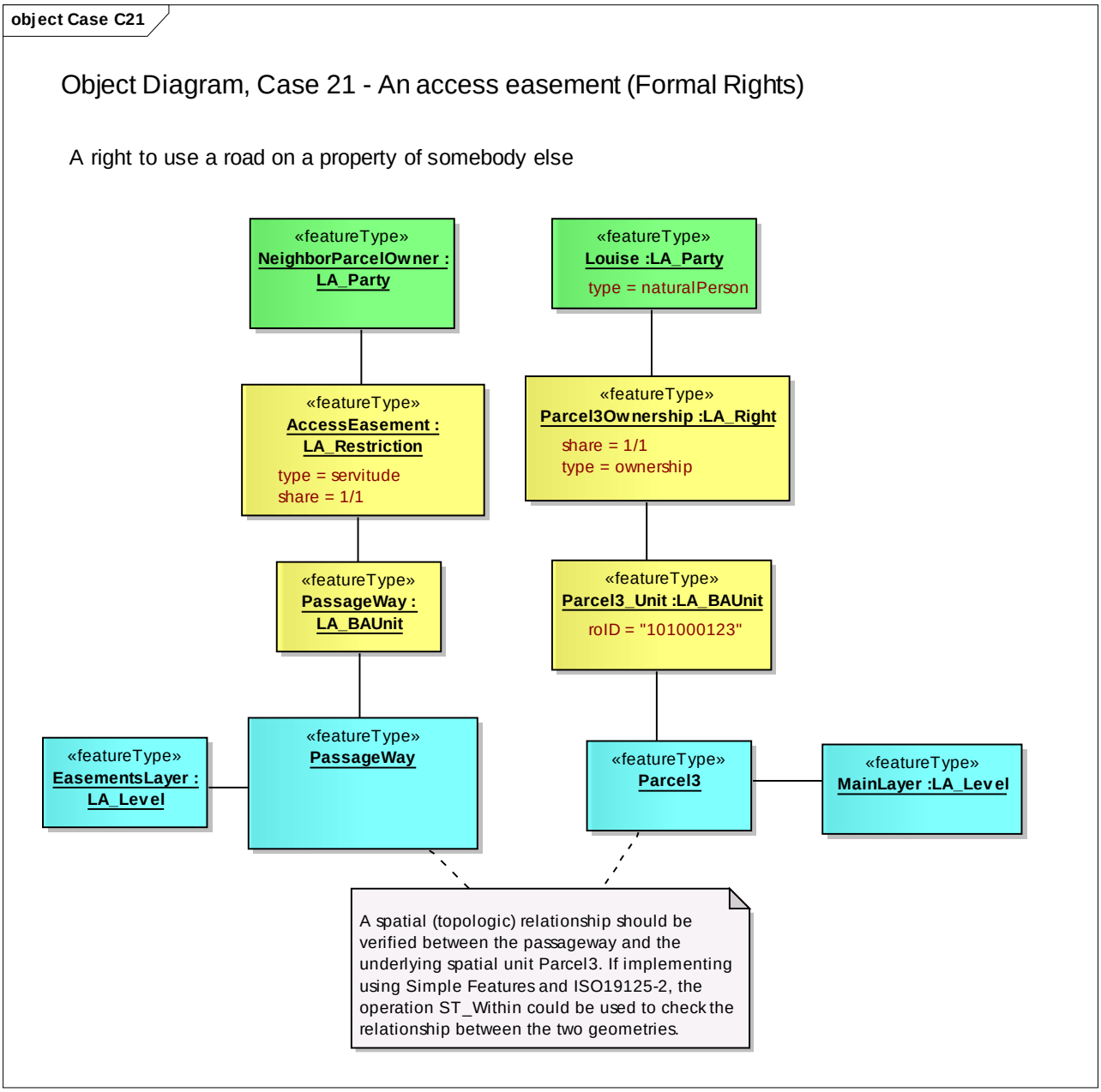
Case C18. Value as basis for taxation valid for five years



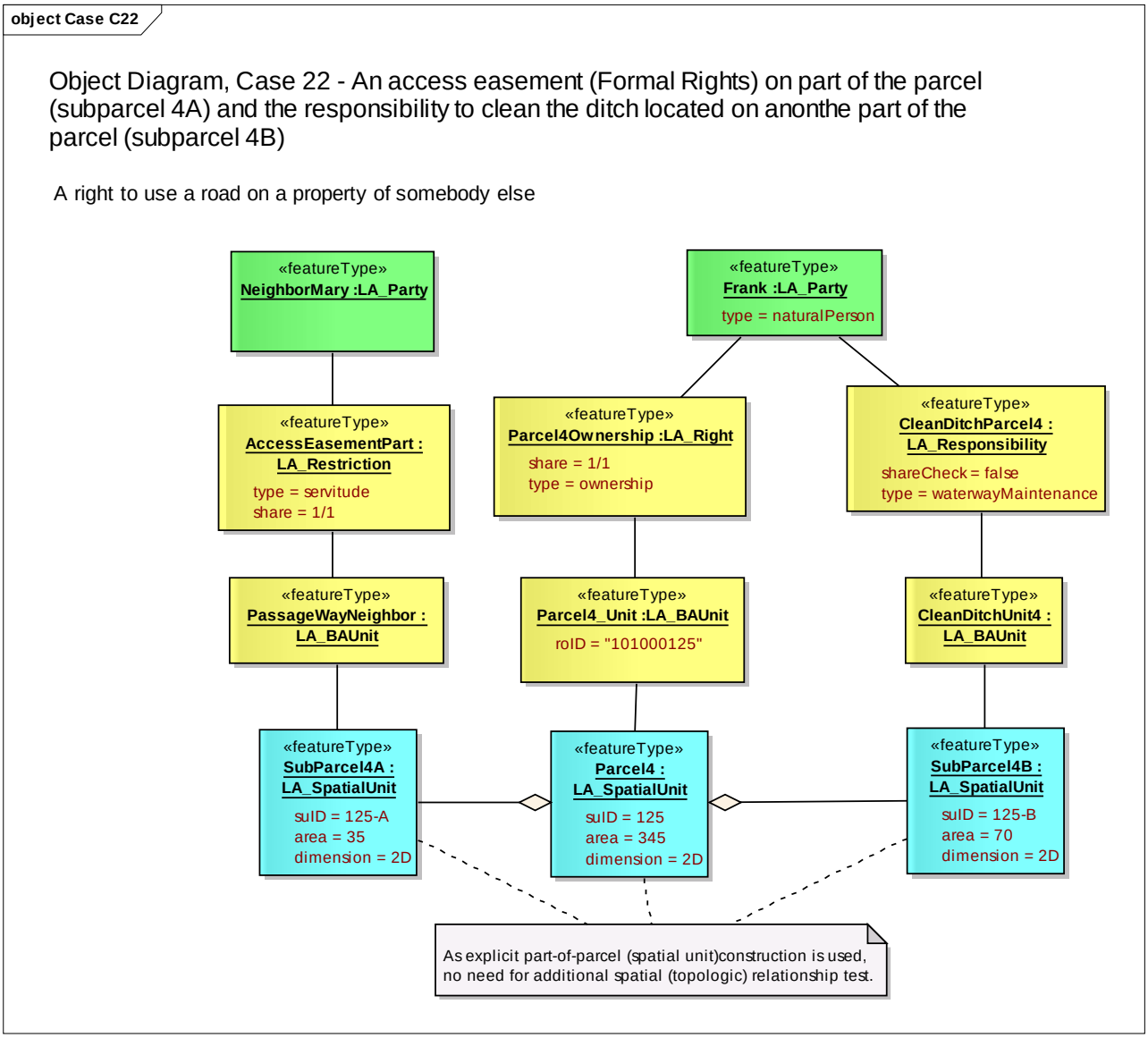
Case C19. A milk right to a spatial unit



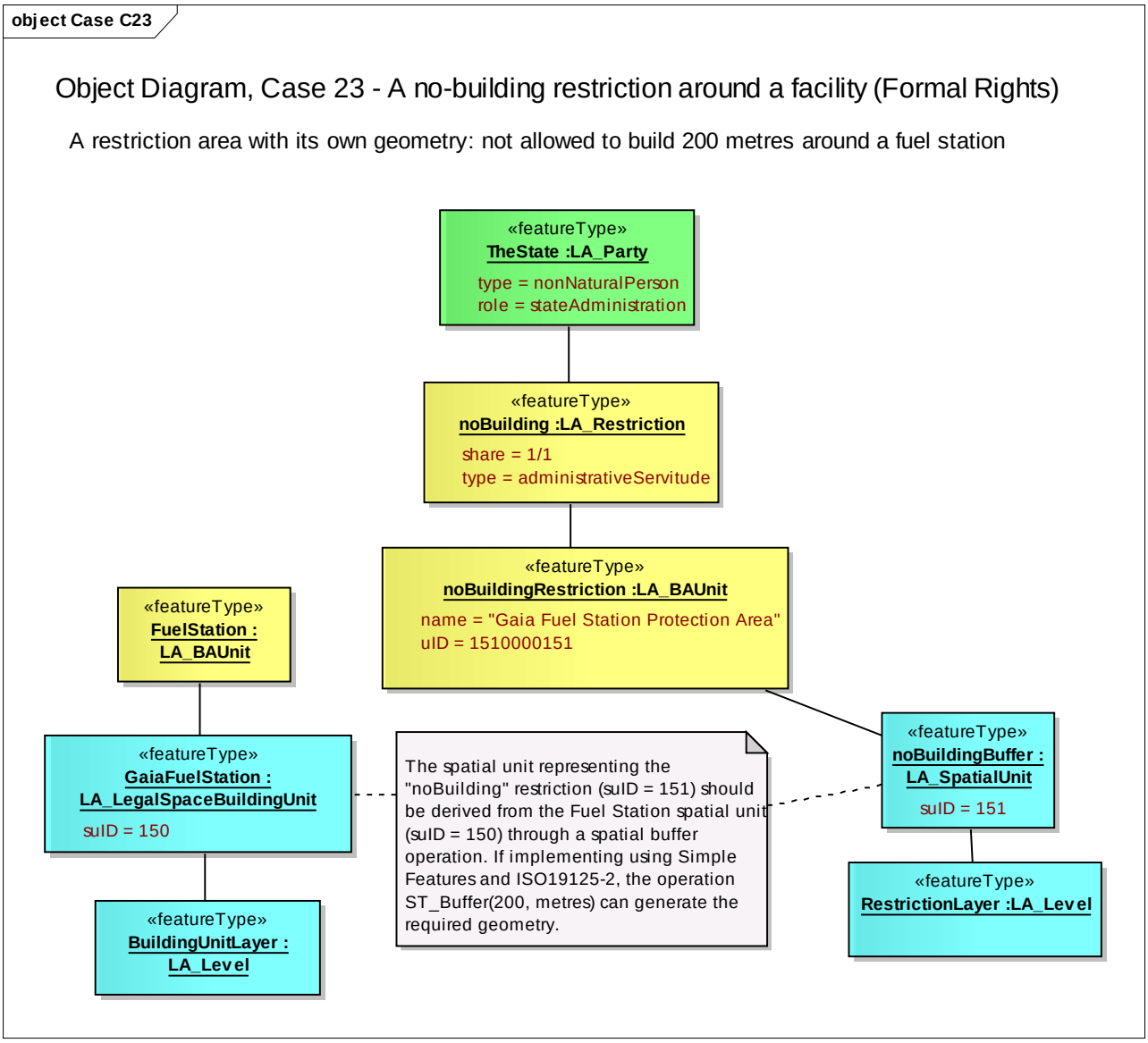
Case C20. A responsibility to clean the ditches



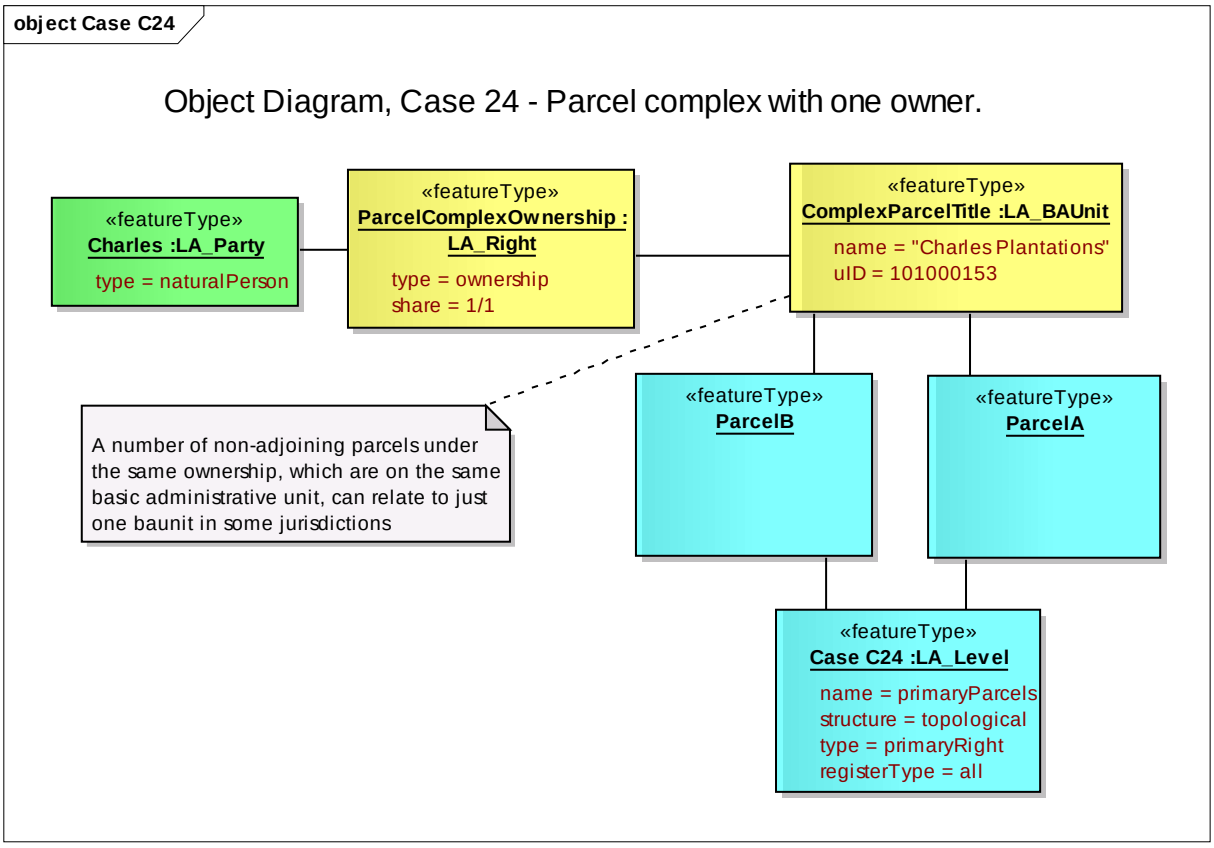
Case C21. A right to use a road on a property of somebody else



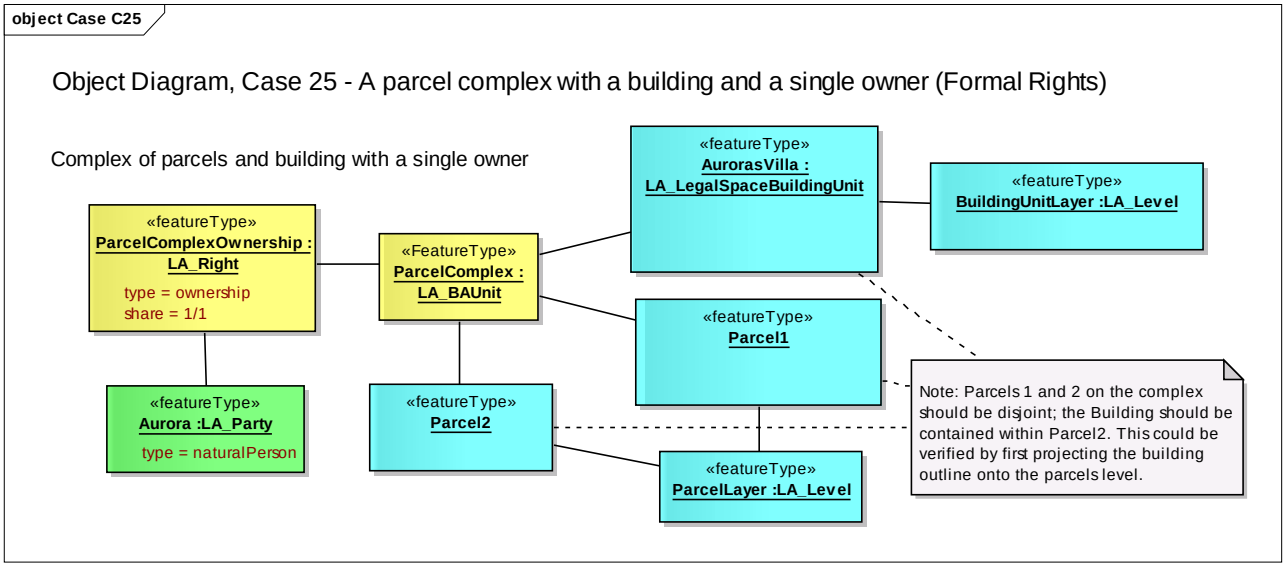
Case C22. A right to use a road on a property of somebody else



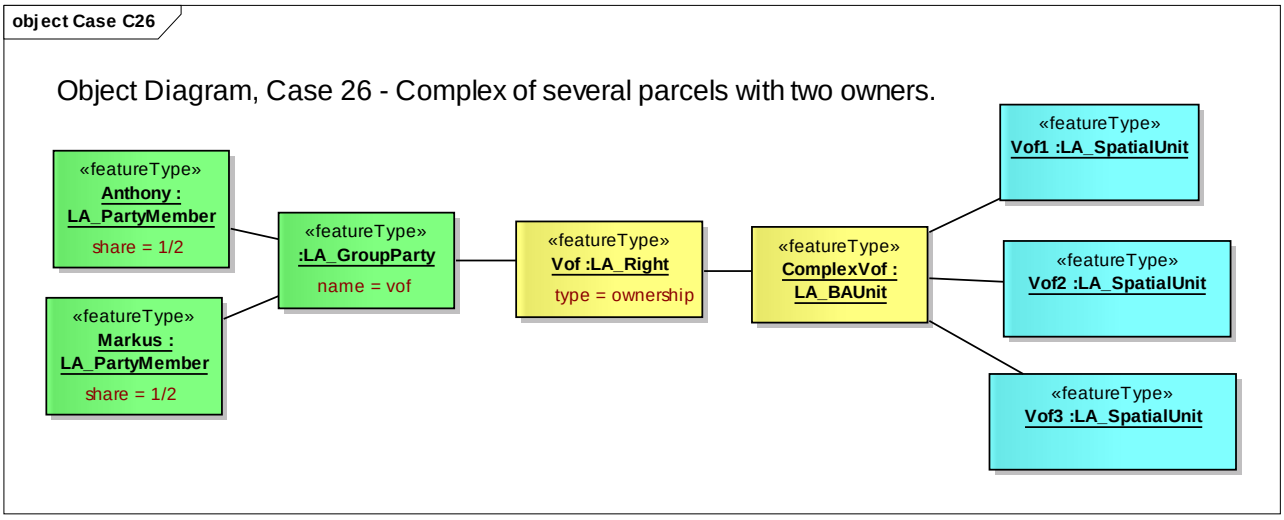
Case C23. A restriction area (“it is not allowed to built within 200 metres of a fuel station”) with its own geometry



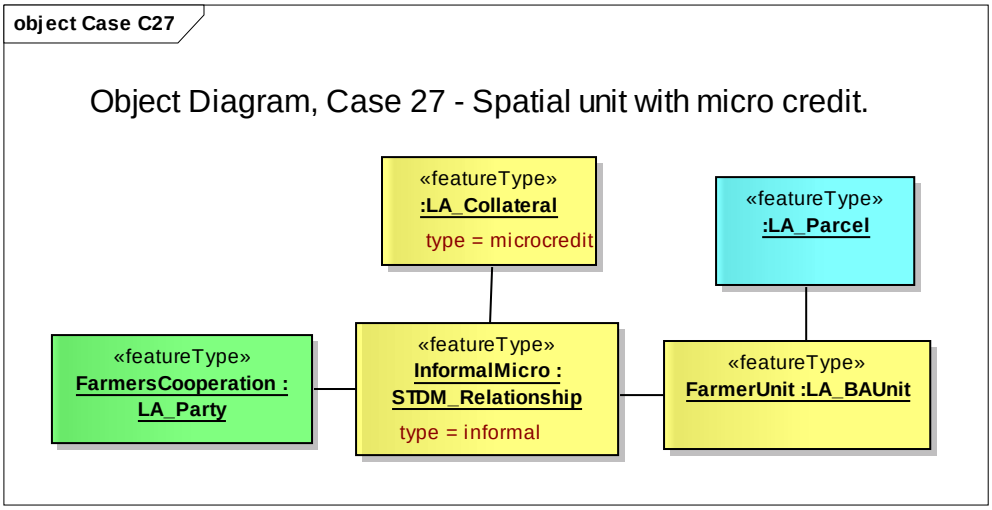
Case C24. Spatial unit complex with one owner



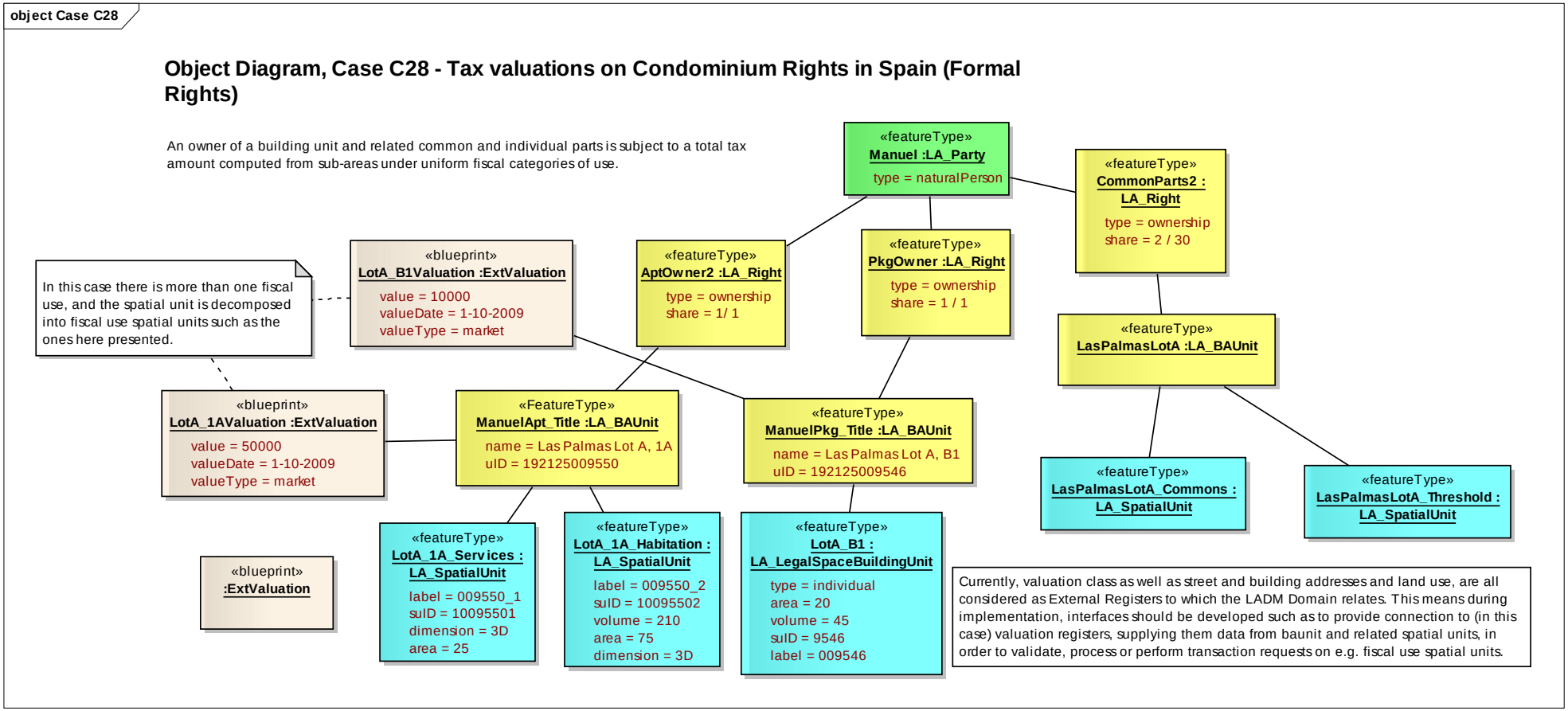
Case C25. Spatial unit complex with building, one owner



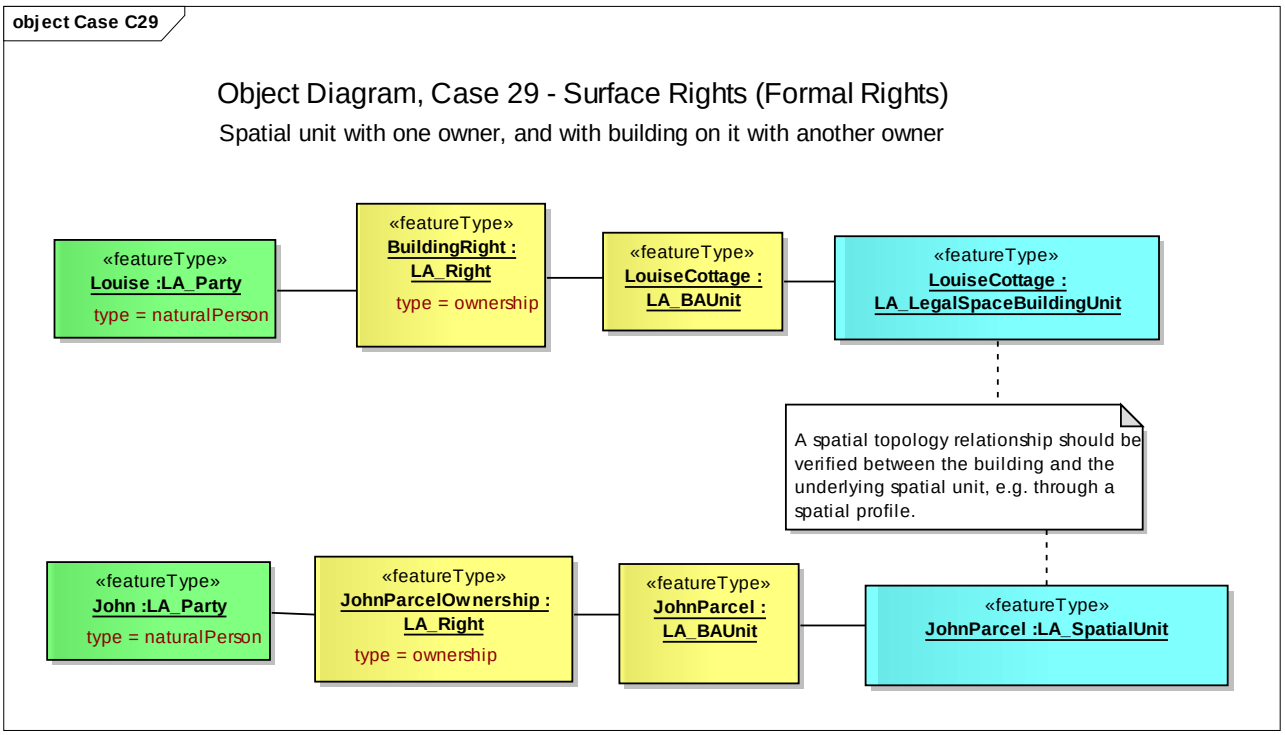
Case C26. Complex of parcels with two owners



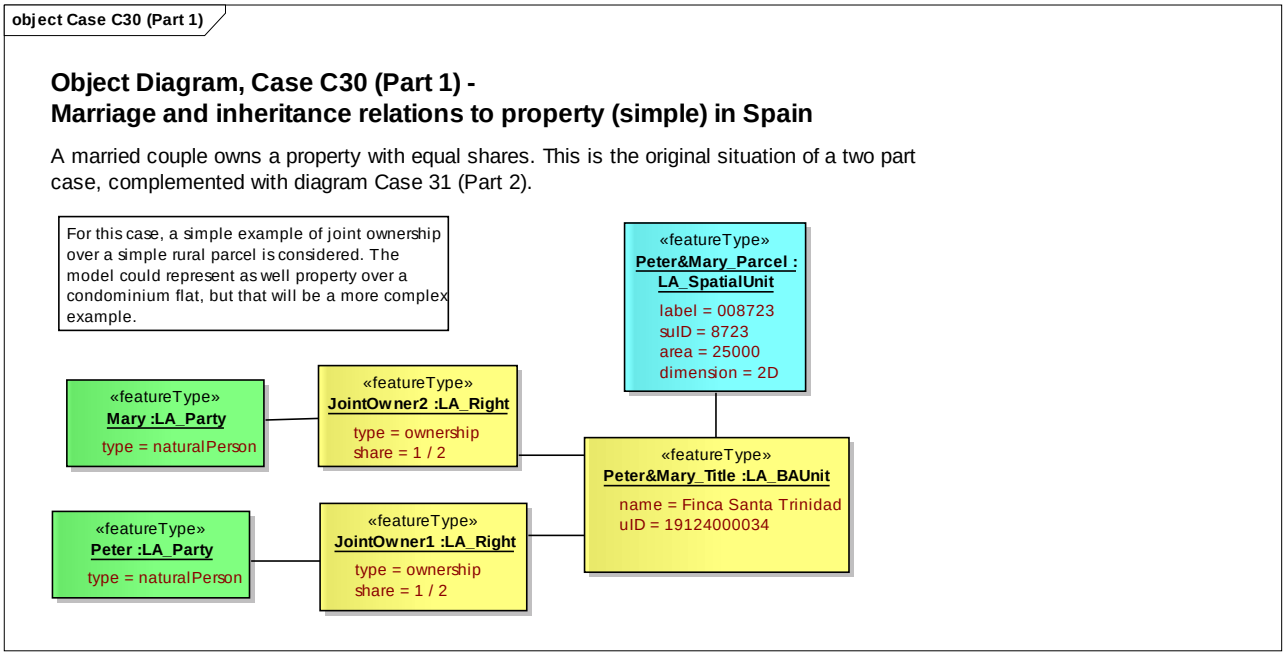
Case C27. Spatial unit with micro credit



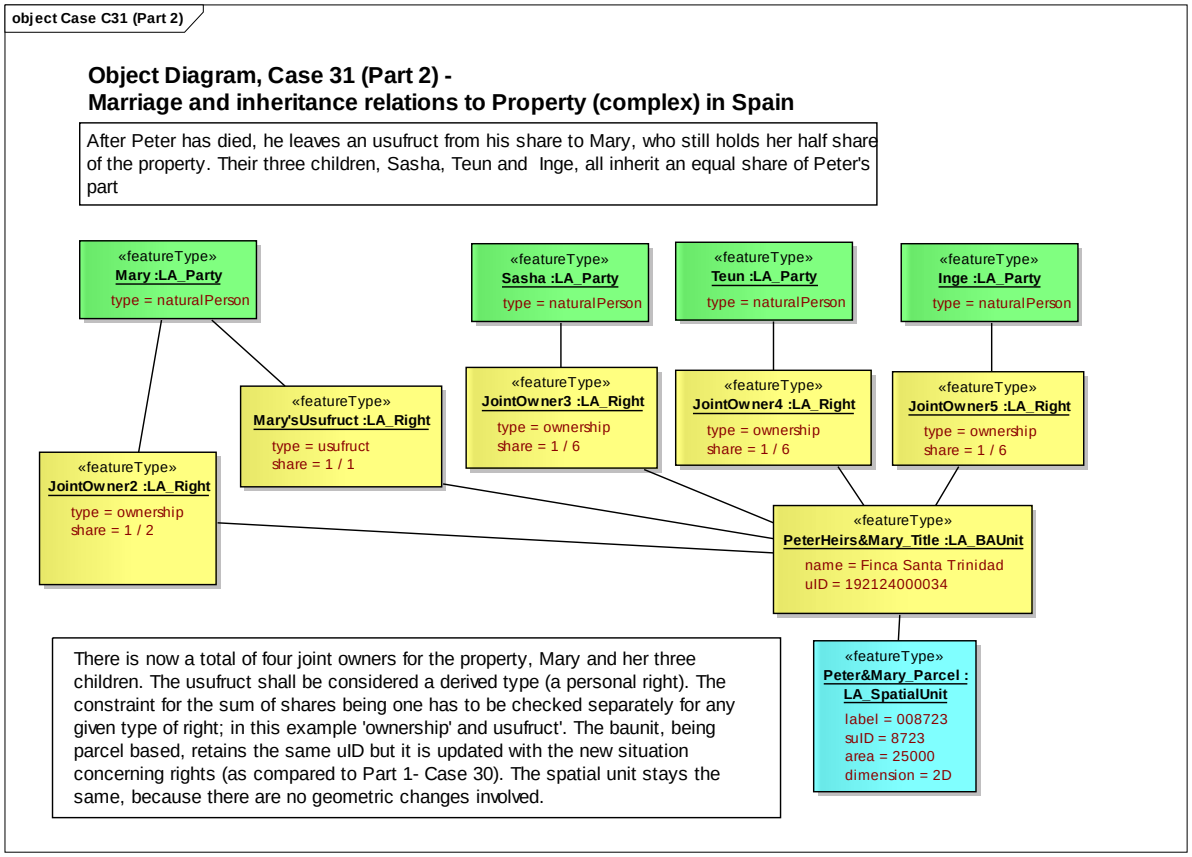
Case C28. Tax valuations on condominium rights in Spain



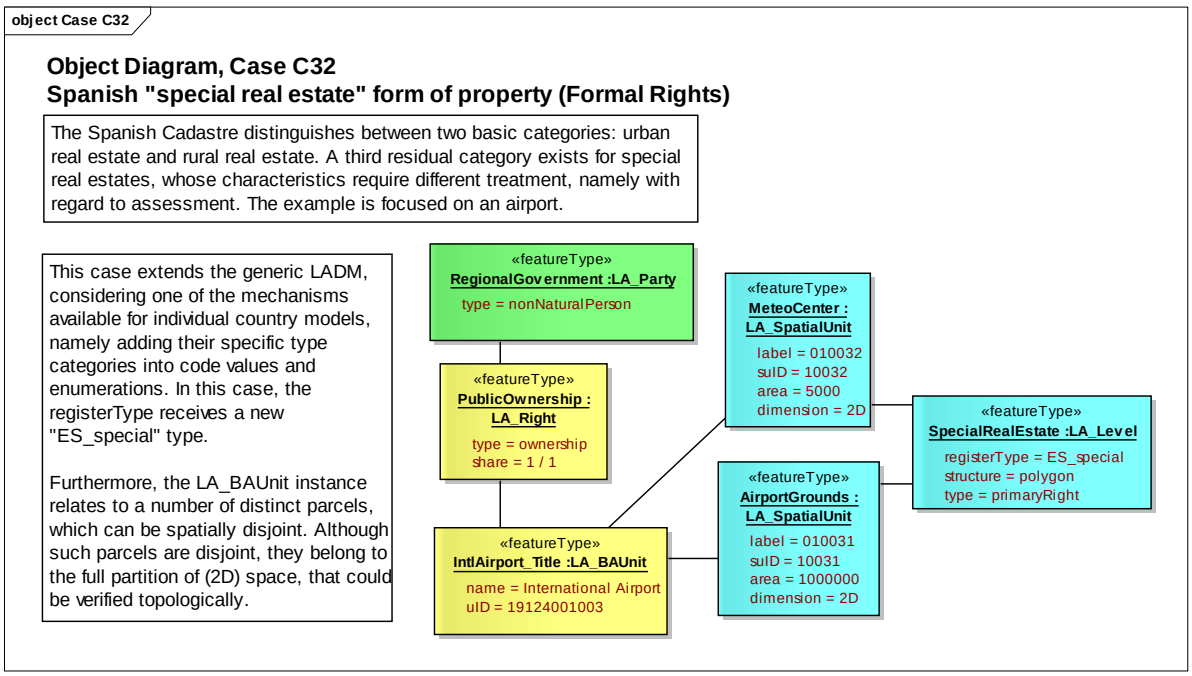
Case C29. A spatial unit with one owner, with a building from a different owner



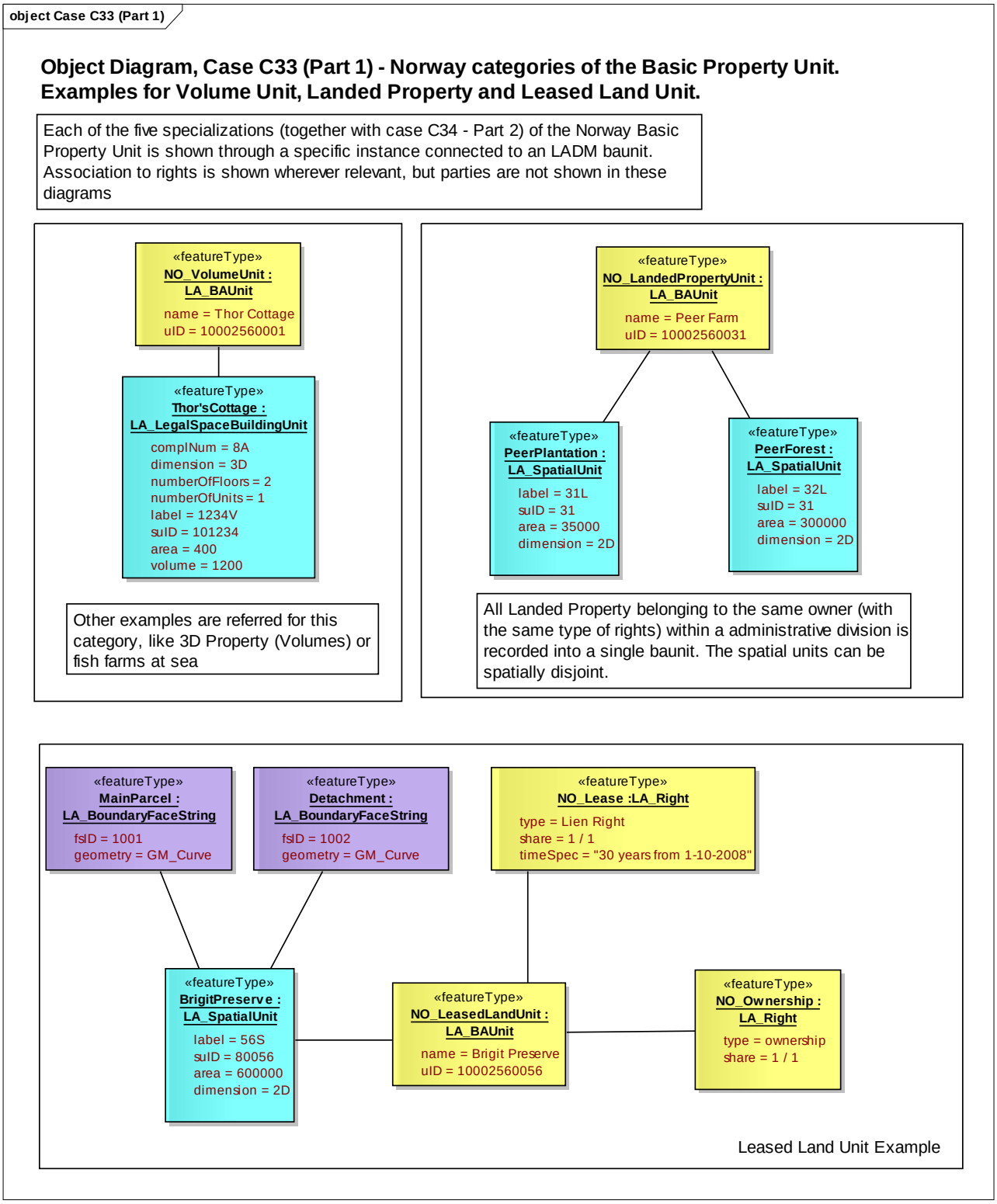
Case C30. Marriage and inheritance relationships to property (simple) in Spain



Case C31. Marriage and inheritance relationships to property (complex) in Spain



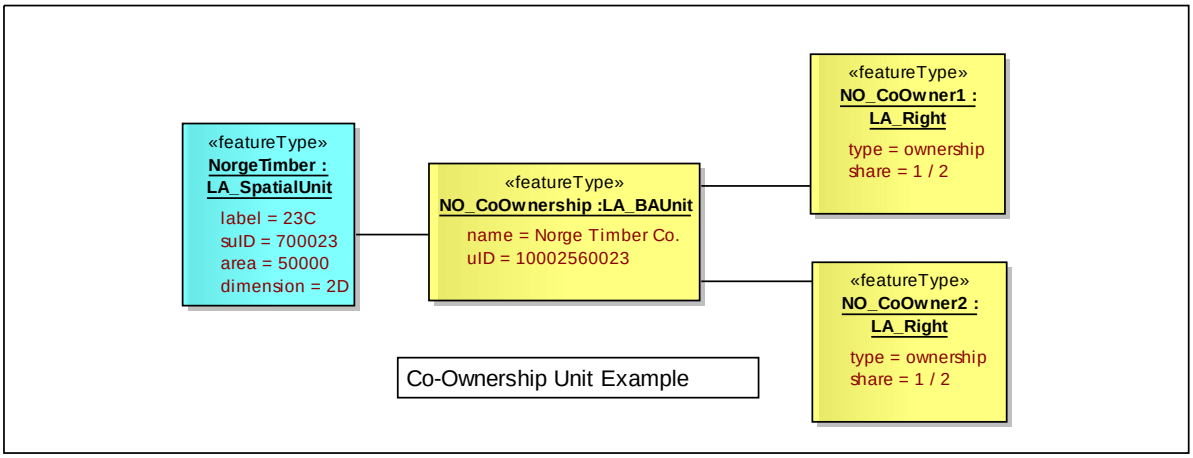
Case C32. Spanish ' special real estate' form of property

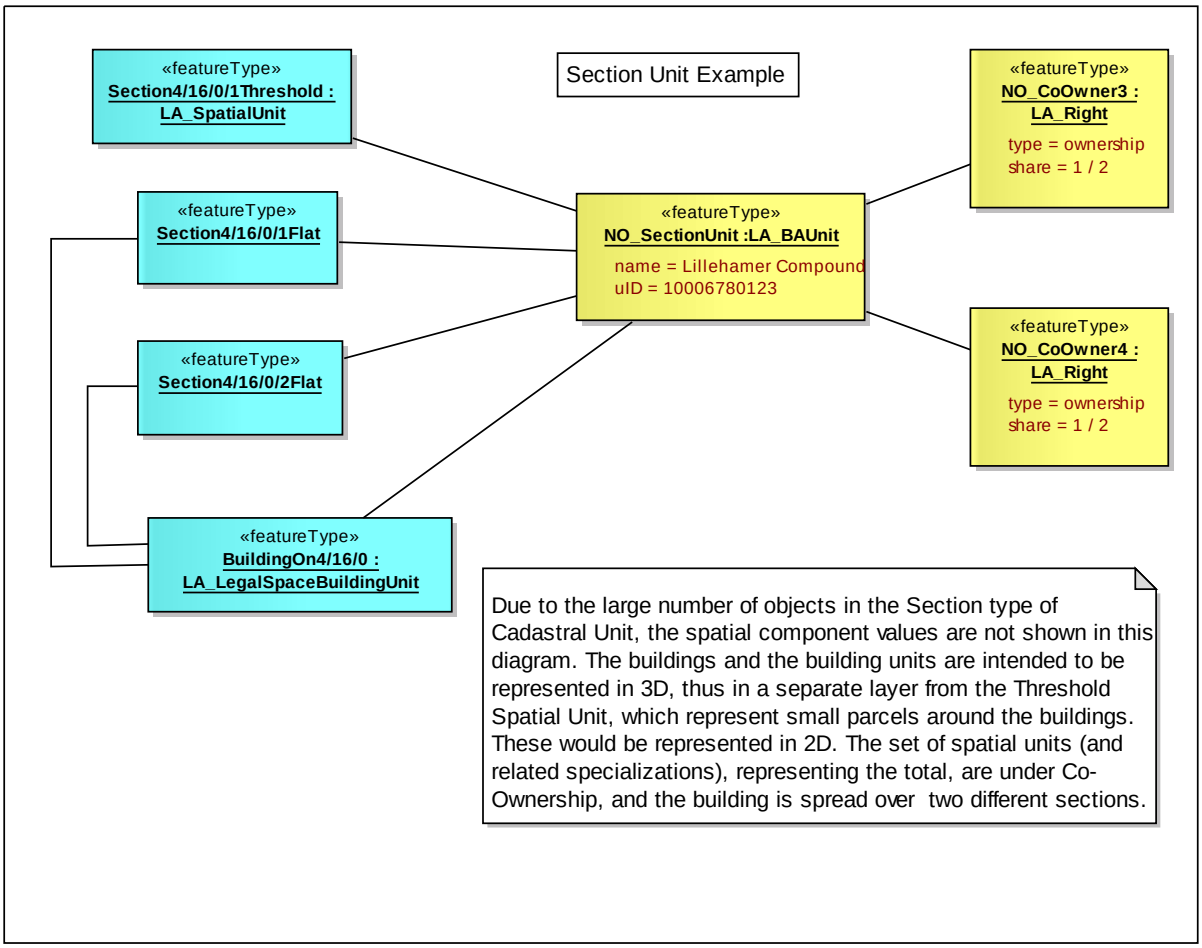


Case C33. Norwegian categories of basic properties

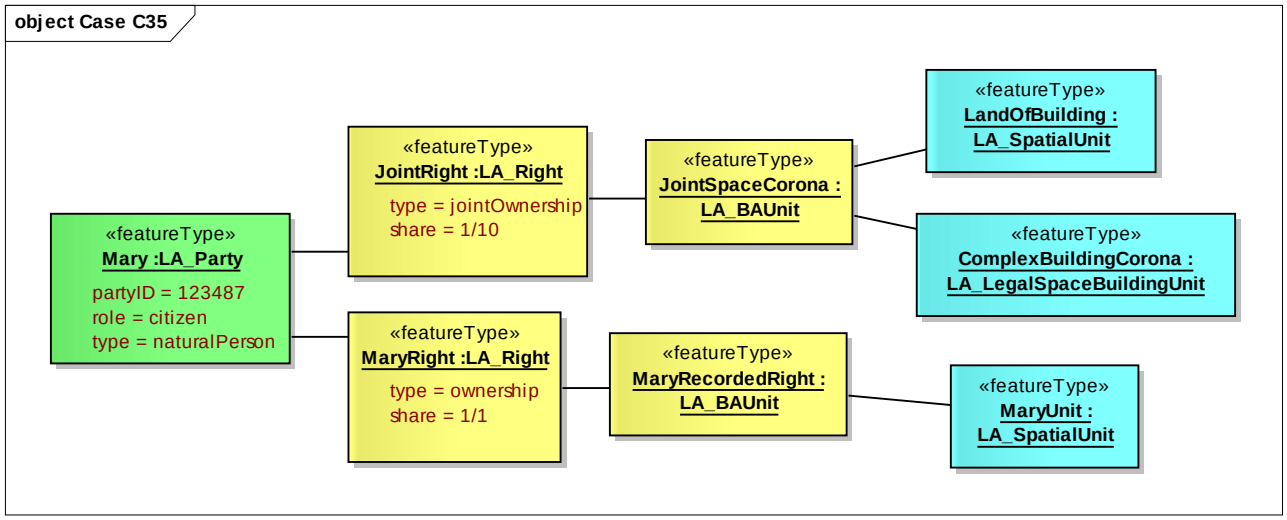
object Case C34 (Part 2)

Object Diagram, Case C34 (Part 2) - Norway Categories of the Basic Property Unit. Examples for a Co-Ownership Unit and a Section Unit.





Case C34. Norwegian categories of basic properties



Case C35. Individual and joint property rights in Spain ('Corona' is the building name)

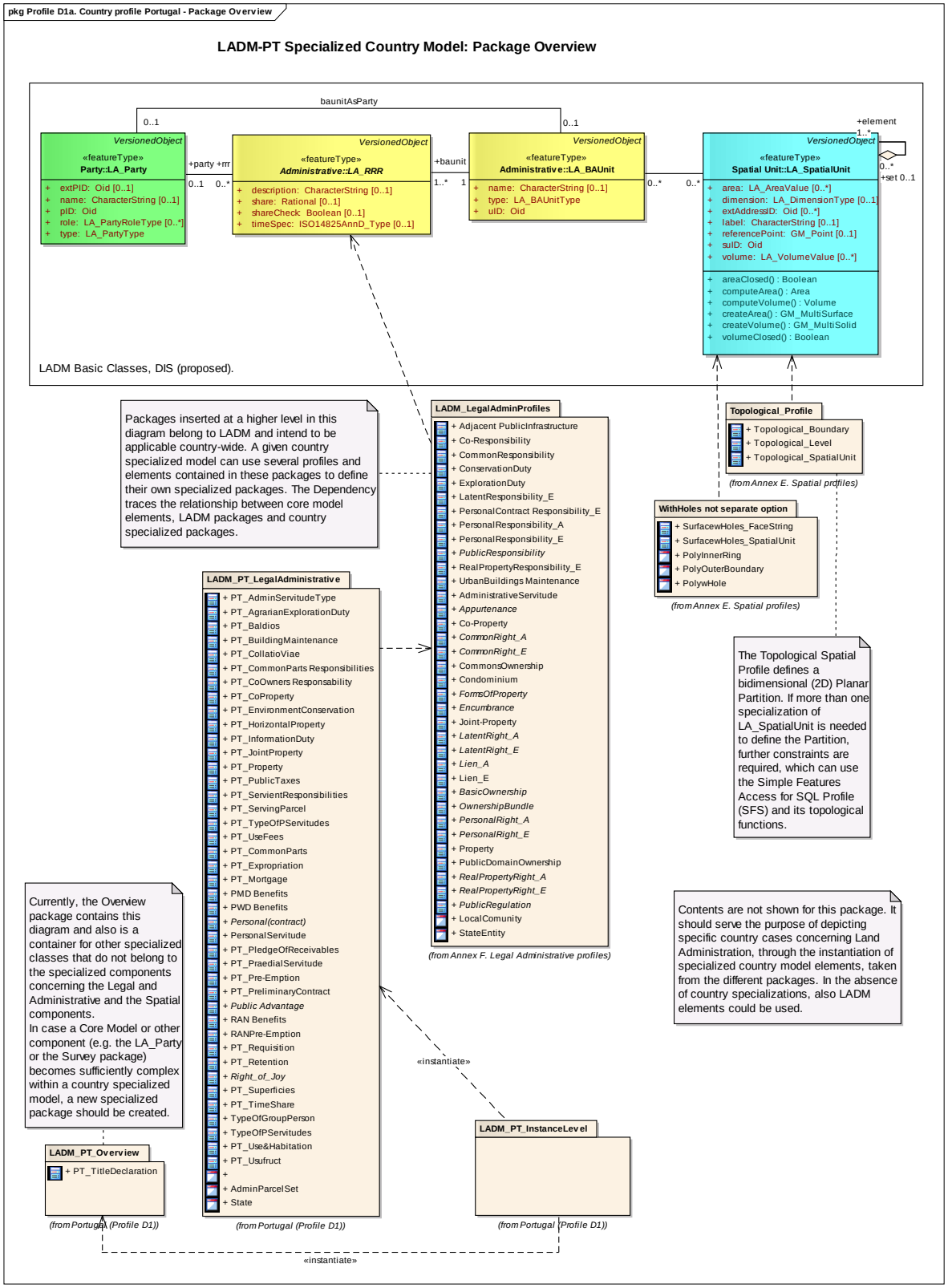
Annex D. Country Profiles (informative)

In this Annex six country profiles of LADM are mentioned:

1. Portugal (Profile D1a and Profile D1b).
2. Queensland, Australia (Profile D2).
3. Indonesia (Profile D3).
4. Japan (Profile D4).
5. Hungary (Profile D5).
6. The Netherlands (Profile D6).

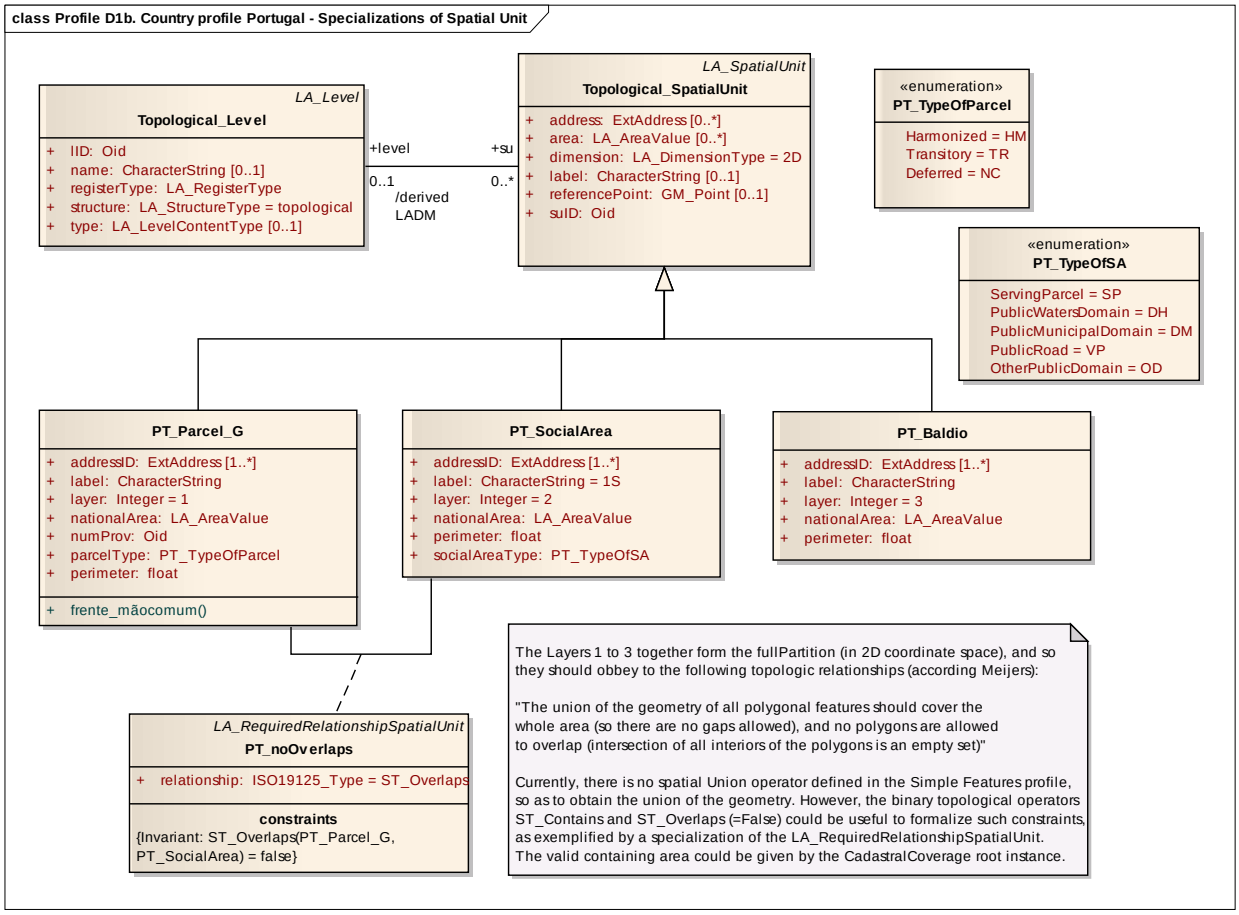
NOTE 1. The *Portuguese Country Profile* is the result of academic research towards a methodology to derive a specialized model from LADM domain model, using state-of-the-art information technologies. Currently, a new Cadastral Data Model complying with a number of ISO standards has been published by the Portuguese Geographic Institute. Work is under way to update this country profile in order to reflect the new specifications.

NOTE2. In *Japan*, local municipalities conduct the cadastral resurvey for improving the precision. The registry offices update the cadastres and land registries based on the resurvey results. The data model for data transfer from municipalities to registry offices is summarized in a UML class diagram. The data model of the information system in the registry offices is not open to the public.



Profile D1a. Country profile Portugal – Package Overview (see NOTE 1 on page 65)

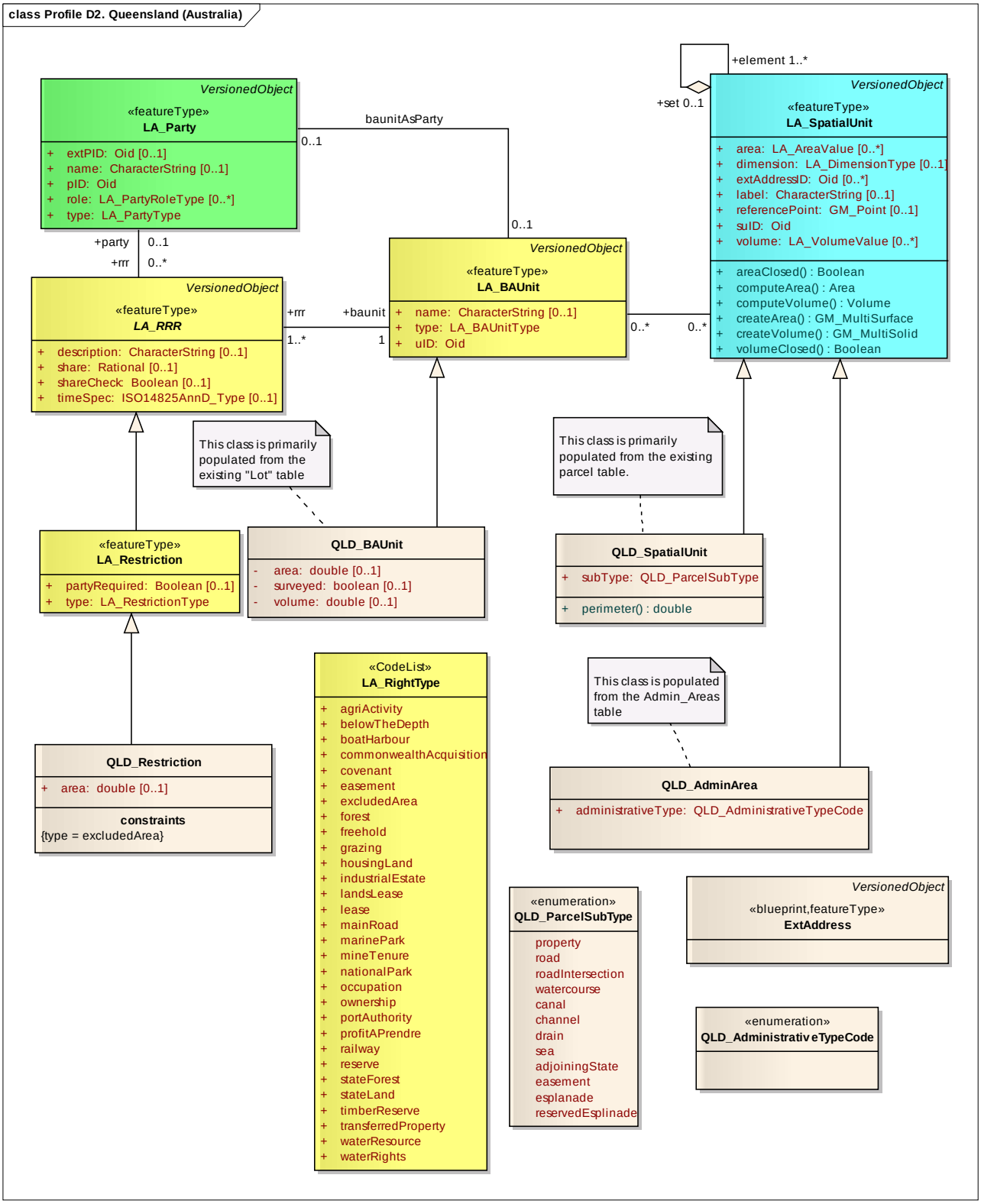
The complete country profile for Portugal includes a number of class diagrams, from which the most relevant are presented here: the package overview (Profile D1a) and the specializations of the LADM package SpatialUnit (Profile D1b).The package overview lists all the classes created for the country profile, grouped into two packages: LegalAdministrative and SpatialUnit. Other packages based on LADM basic classes LA_Party and LA_BAUnit were not developed further in this profile, so standard classes are used. The overview shows the dependencies between standard and country profile packages, and the use of two LADM Spatial Profiles: 2D Topological (Profile E5) and 2D Polygon (Profile E4). Several instance level diagrams were also created, showing concrete examples combining legal and spatial unit objects. This country profile shows how a further level of detail can be attained from the specialization of LADM packages and the use of LADM profiles. The SpatialUnit specializations define three classes, which belong to the topological Structure Type and as such are 2-dimensional and together form a planar partition. As explained in the diagram note, further constraints should be defined in order to implement such classes, namely in a spatial database.



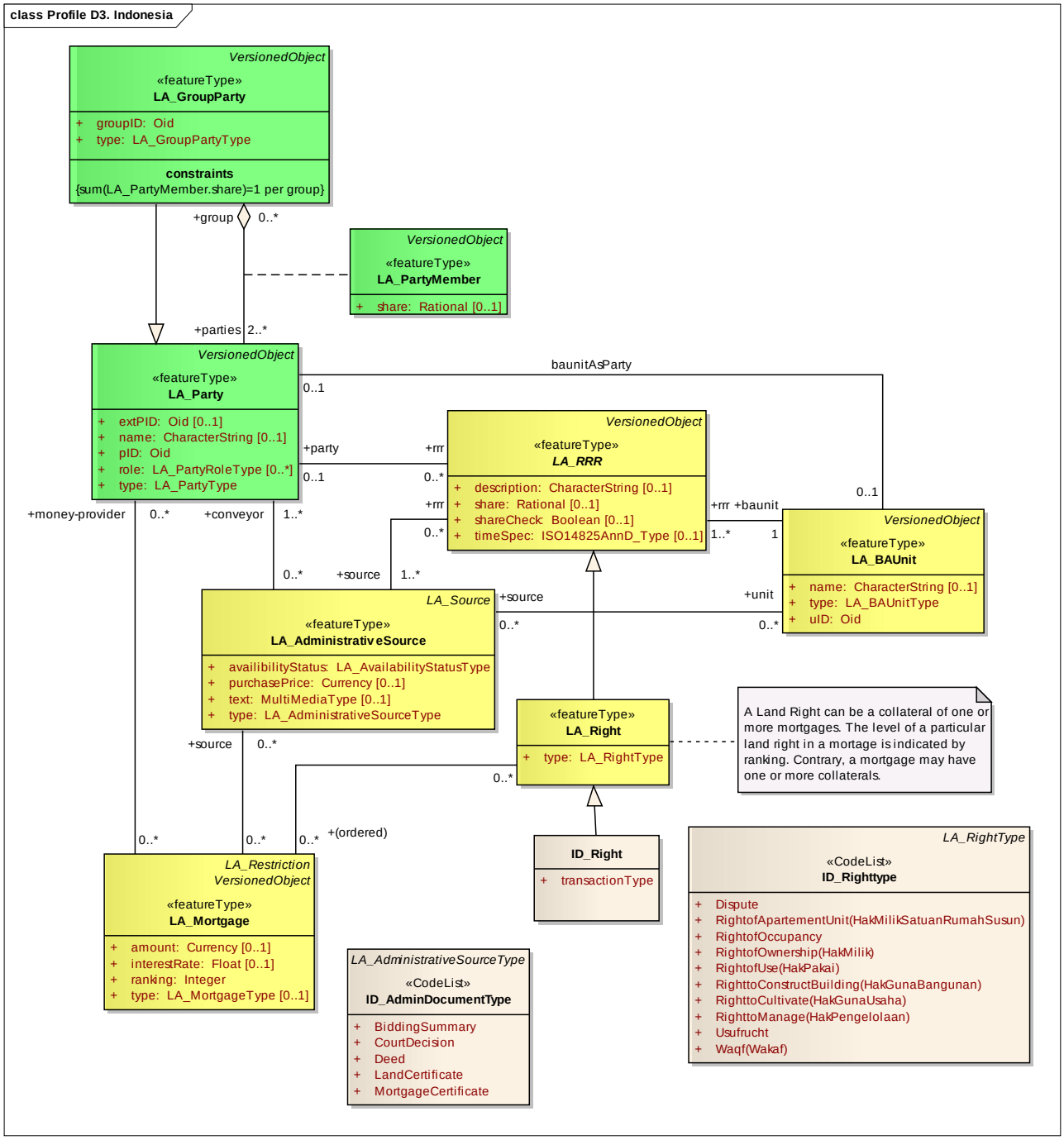
Profile D1b. Country profile Portugal – Specializations of Spatial Unit (see NOTE 1 on page 65)

The concept behind this diagram is that any location within the country territory should be covered by one instance of the three classes, that is, any location has to be classified as a PT_ParcelG, a PT_SocialArea or a PT_Baldio. The following list has brief definitions of these classes, which are ultimately rooted in the legal framework:

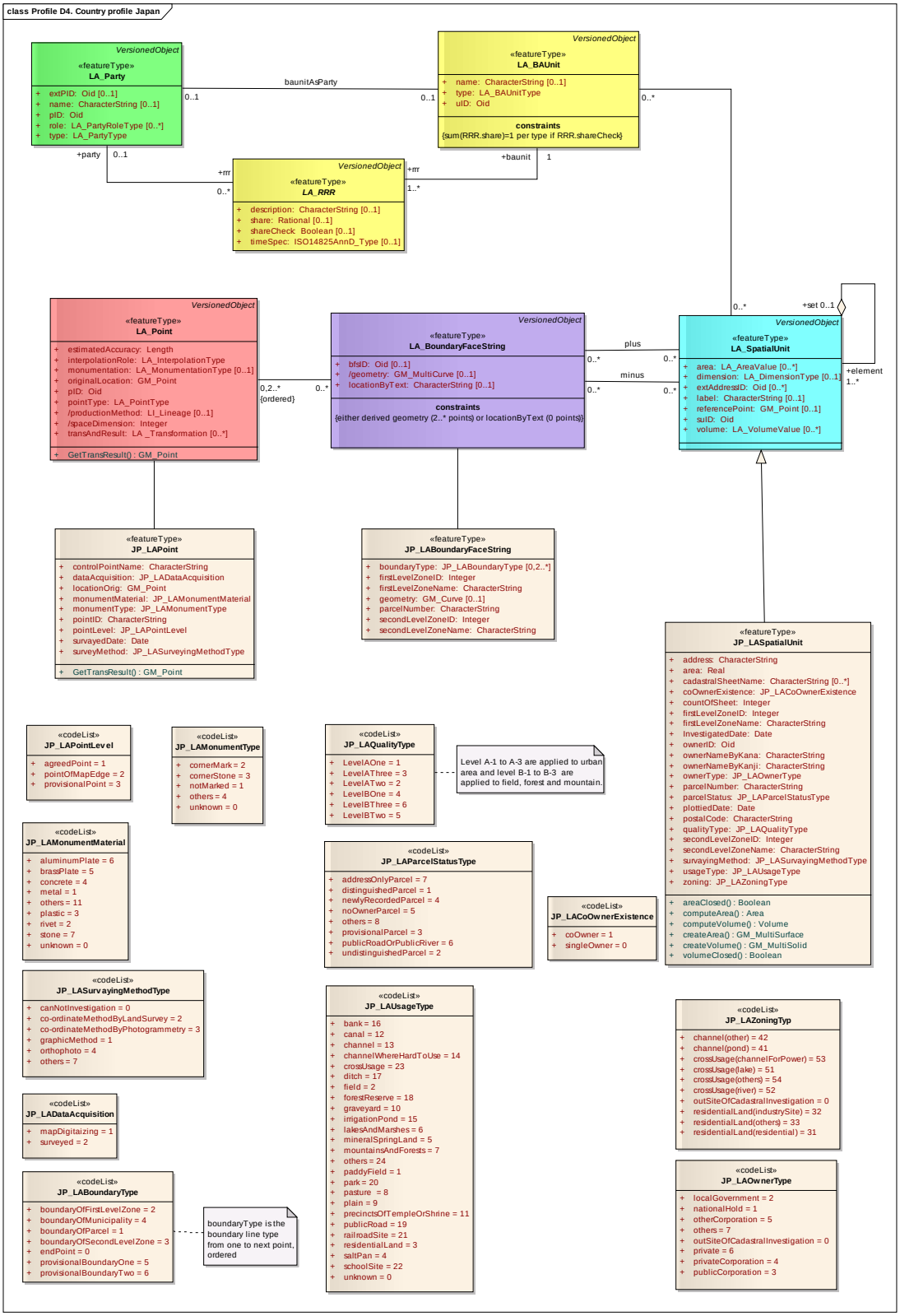
- PT_ParcelG: spatial class representing a parcel belonging to the private immovable property legal regime. These are the parcels which should be legaly registered as forming an autonomous juridical entity
- PT_SocialArea: public roads serving several parcels, or other areas of the municipal or national public domain (which are not under the private property regime)
- PT_Baldio: a spatial class under a specific legal regime, which is owned by the local community, as recognized in the Portuguese Constitution.



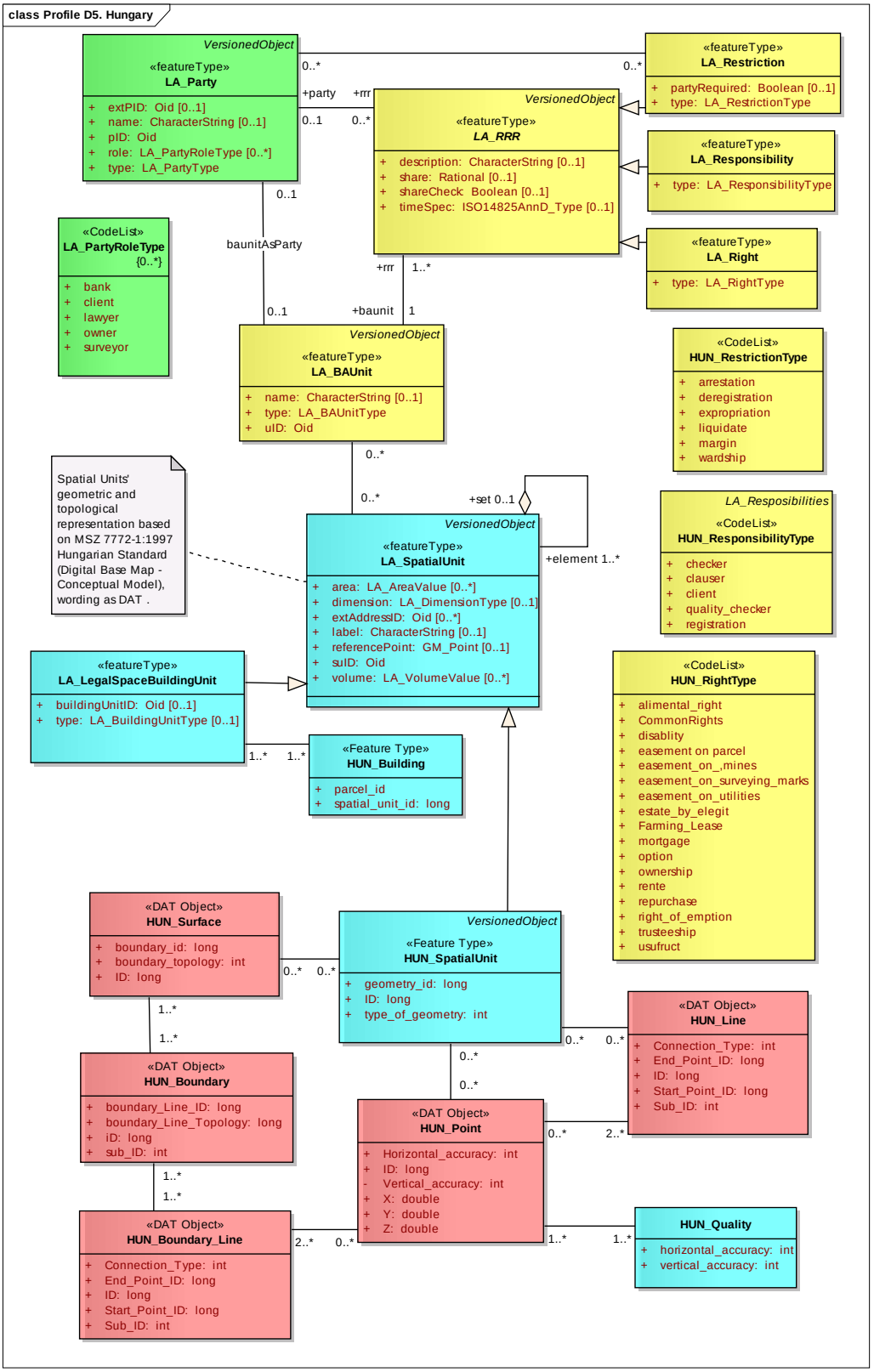
Profile D2. Country profile Queensland (Australia)



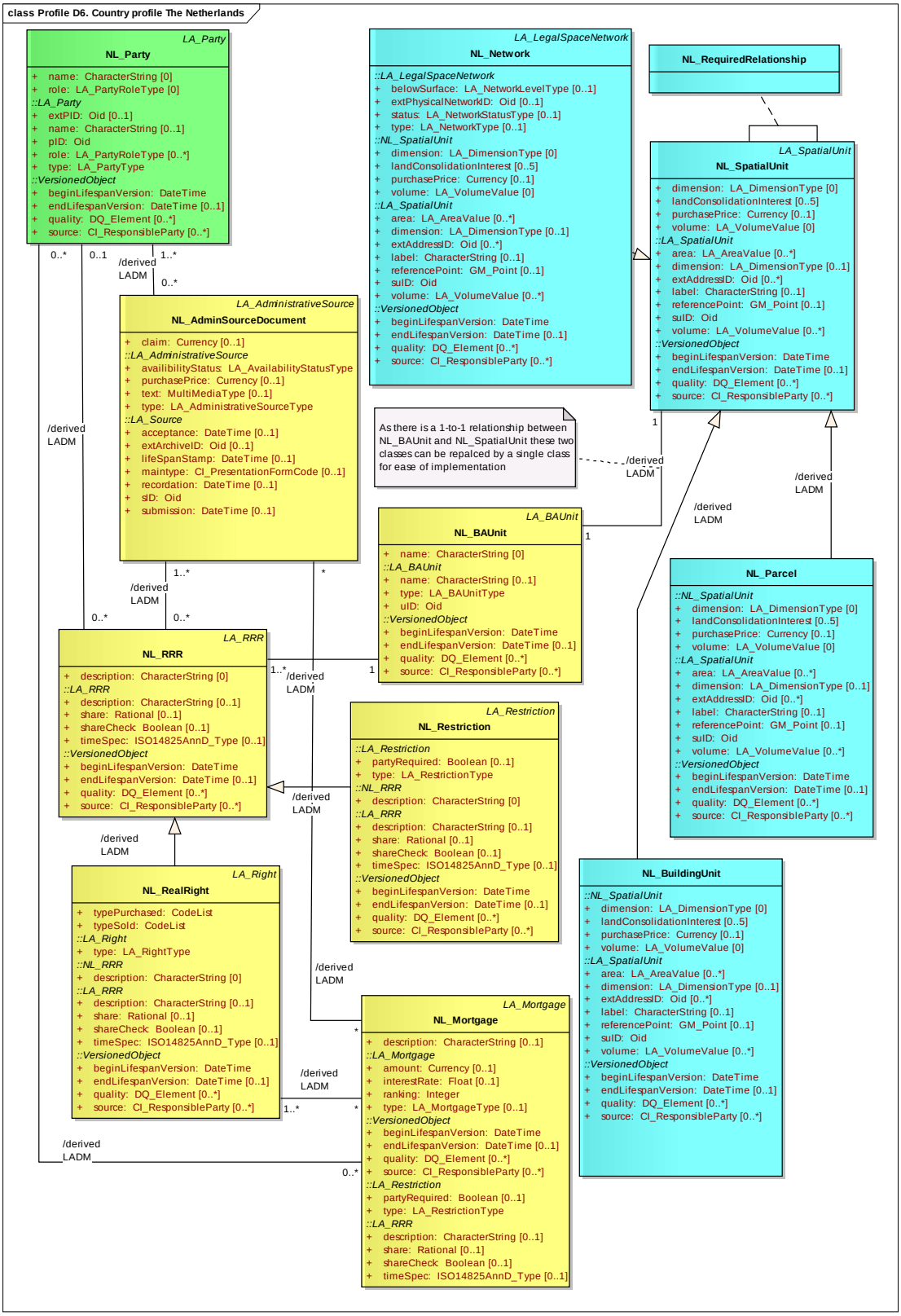
Profile D3. Country profile Indonesia



Profile D4. Country profile Japan (see NOTE 2 on page 65)



Profile D5. Country profile Hungary

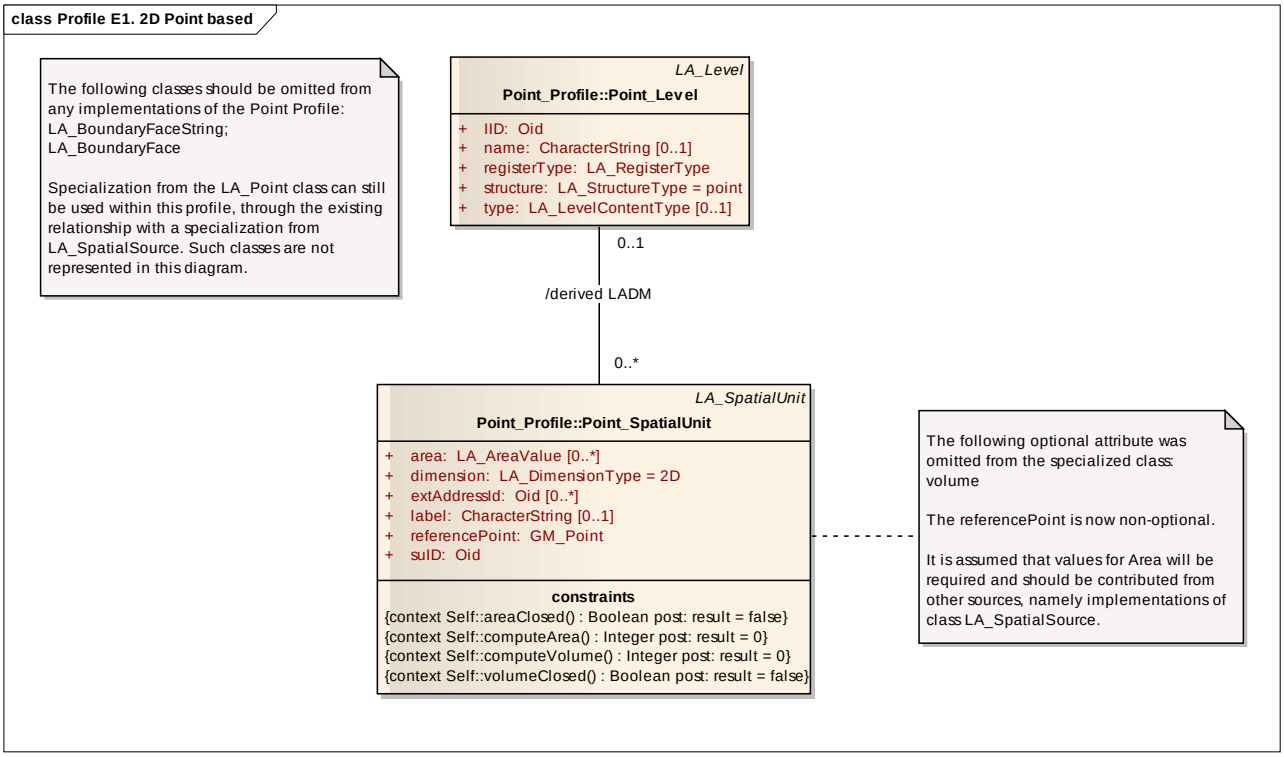


Profile D6. Country profile The Netherlands

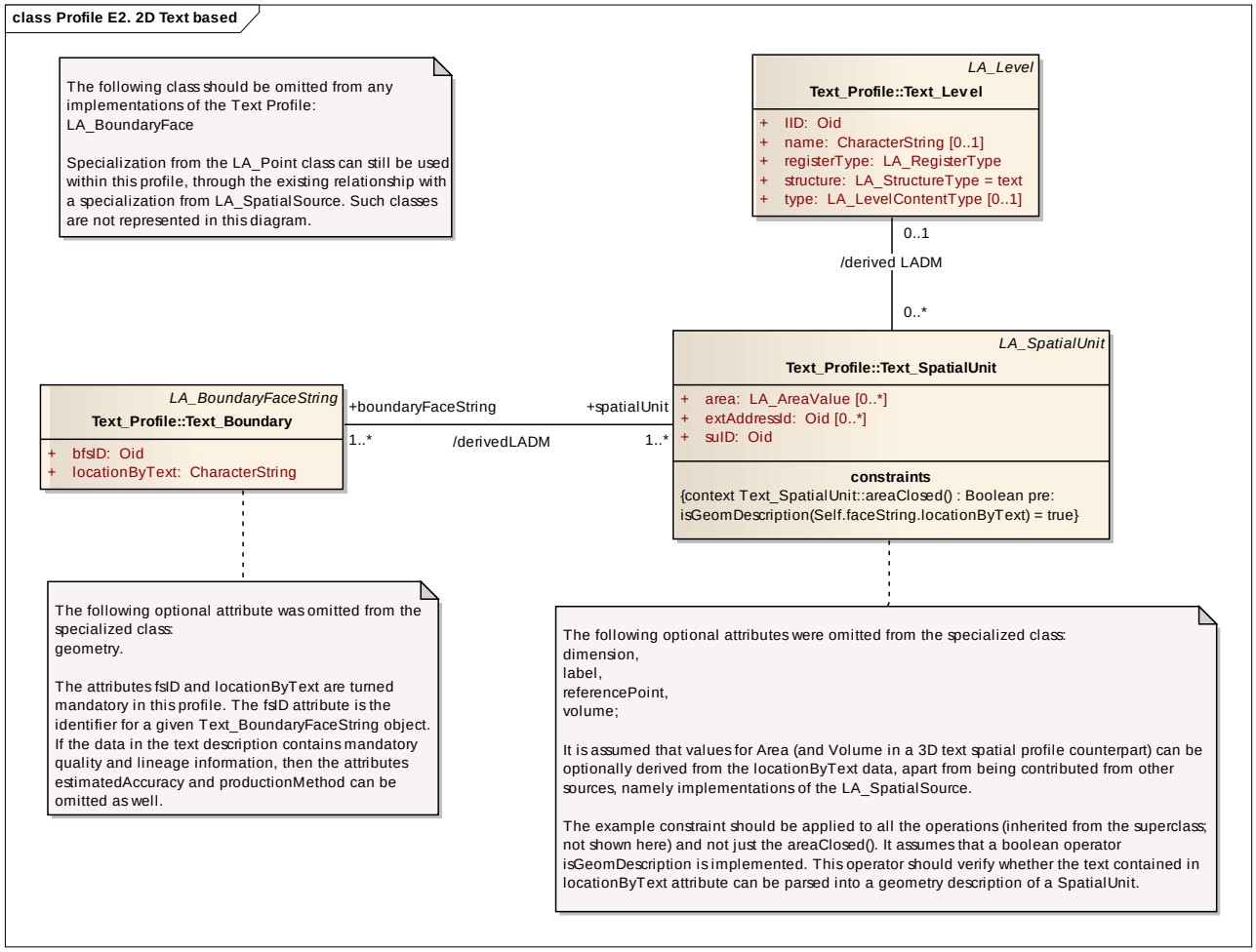
Annex E. Spatial Profiles (informative)

The Spatial Representation subpackage of LADM (Clause 5.5.2) allows a large number of possible representations of spatial units in 2D, 3D, or mixed (2D and 3D). For one specific type of spatial representation, there are often just a limited number of classes and attributes needed. This Annex shows per spatial profile the needed classes and attributes. The 3D cases also cover mixed 2D and 3D configurations. Further, in a specific country profile it is possible to combine several spatial profiles; e.g. spatial units with 2D topology and buildings with 2D polygons.

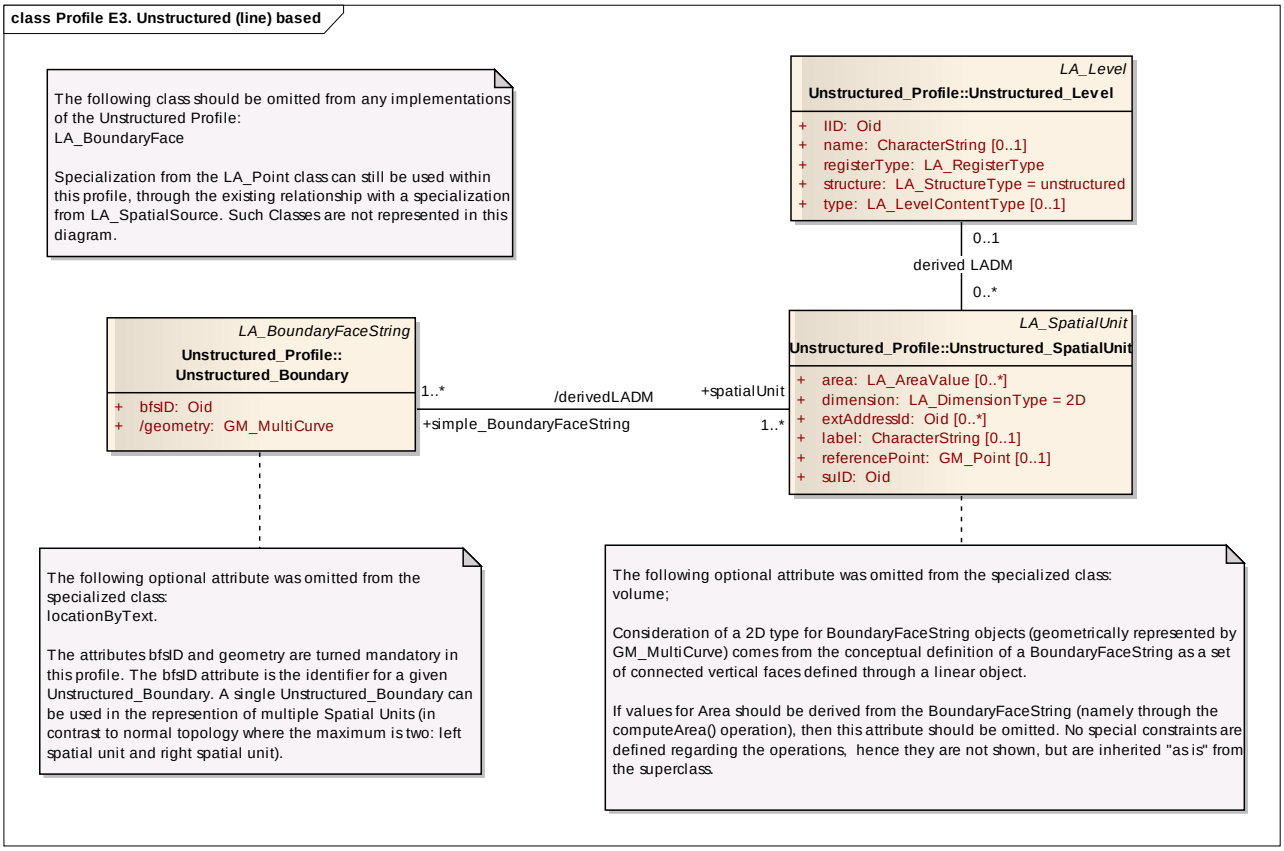
- 2D Point based (Profile E1)
- 2D Text based (Profile E2)
- 2D Unstructured (line) based (Profile E3)
- 2D Polygon based (Profile E4)
- 2D Topological based (Profile E5)
- 3D Topological based (Profile E6)



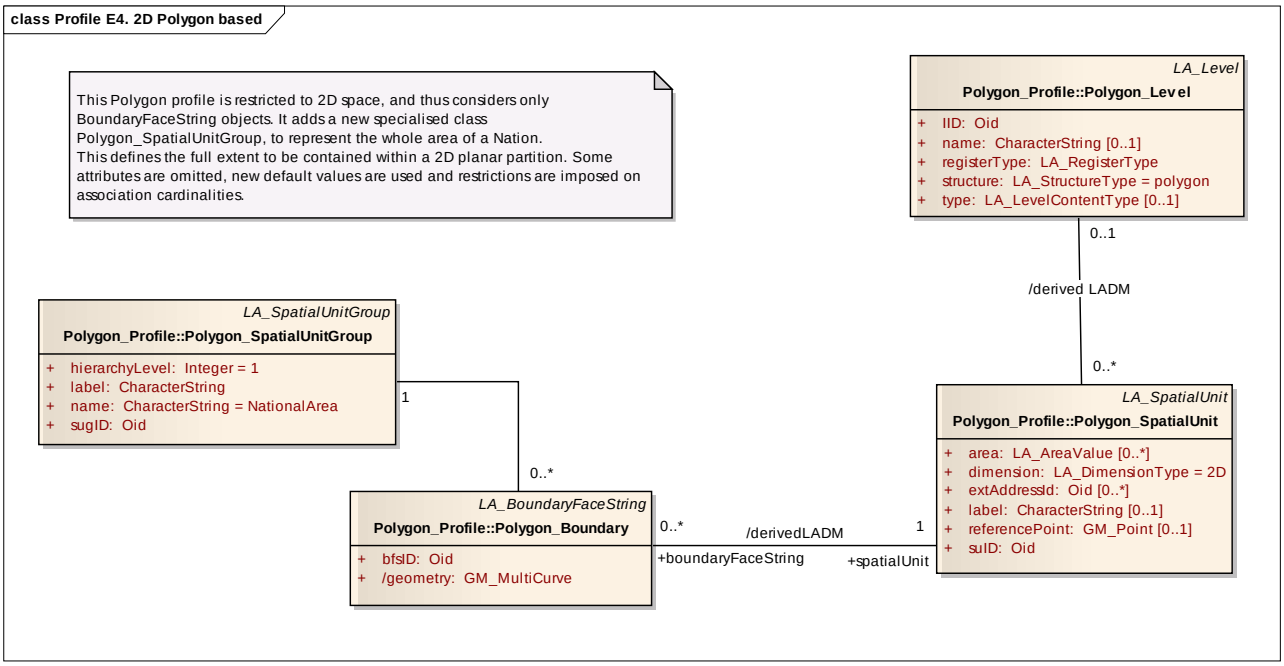
Profile E1. 2D Point based



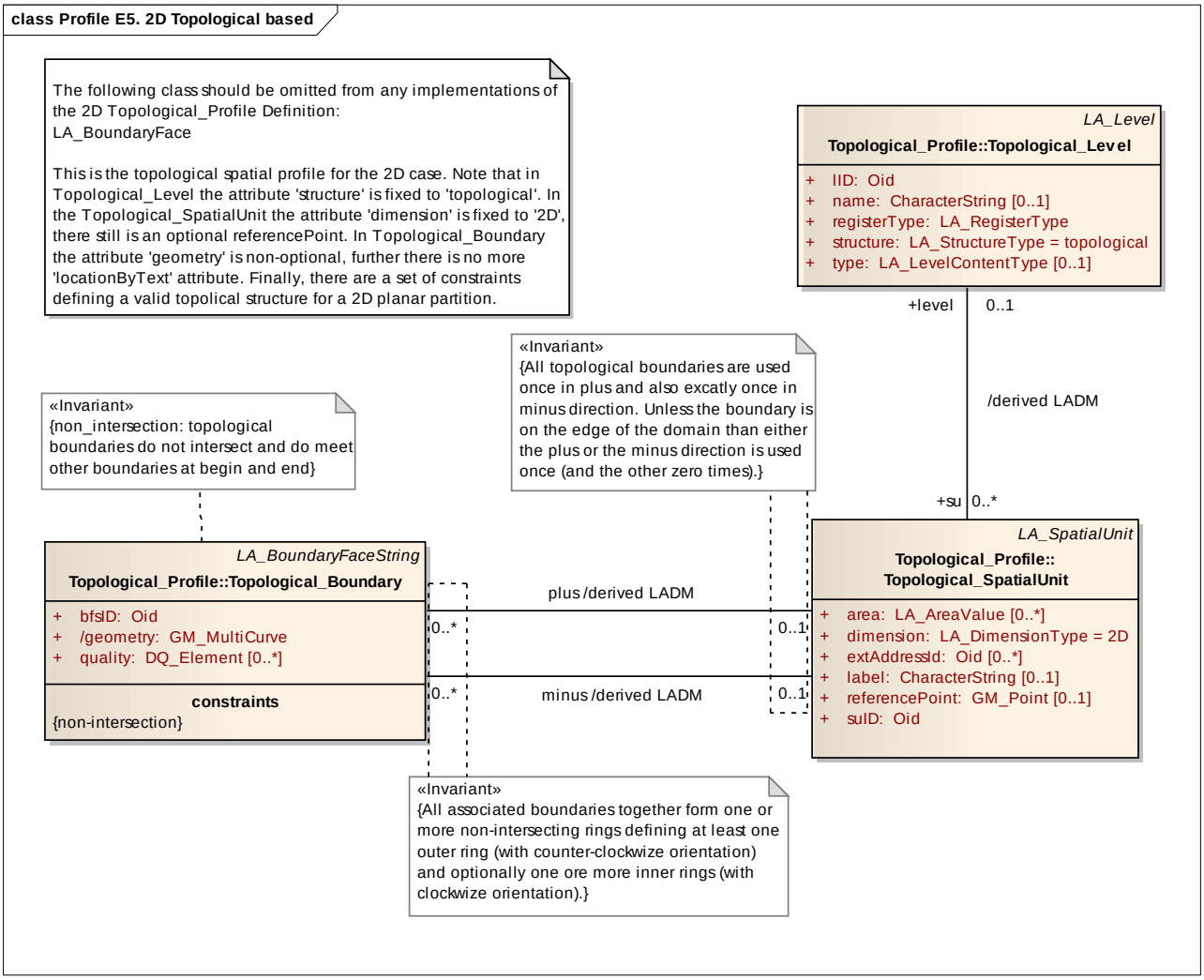
Profile E2. 2D Text based



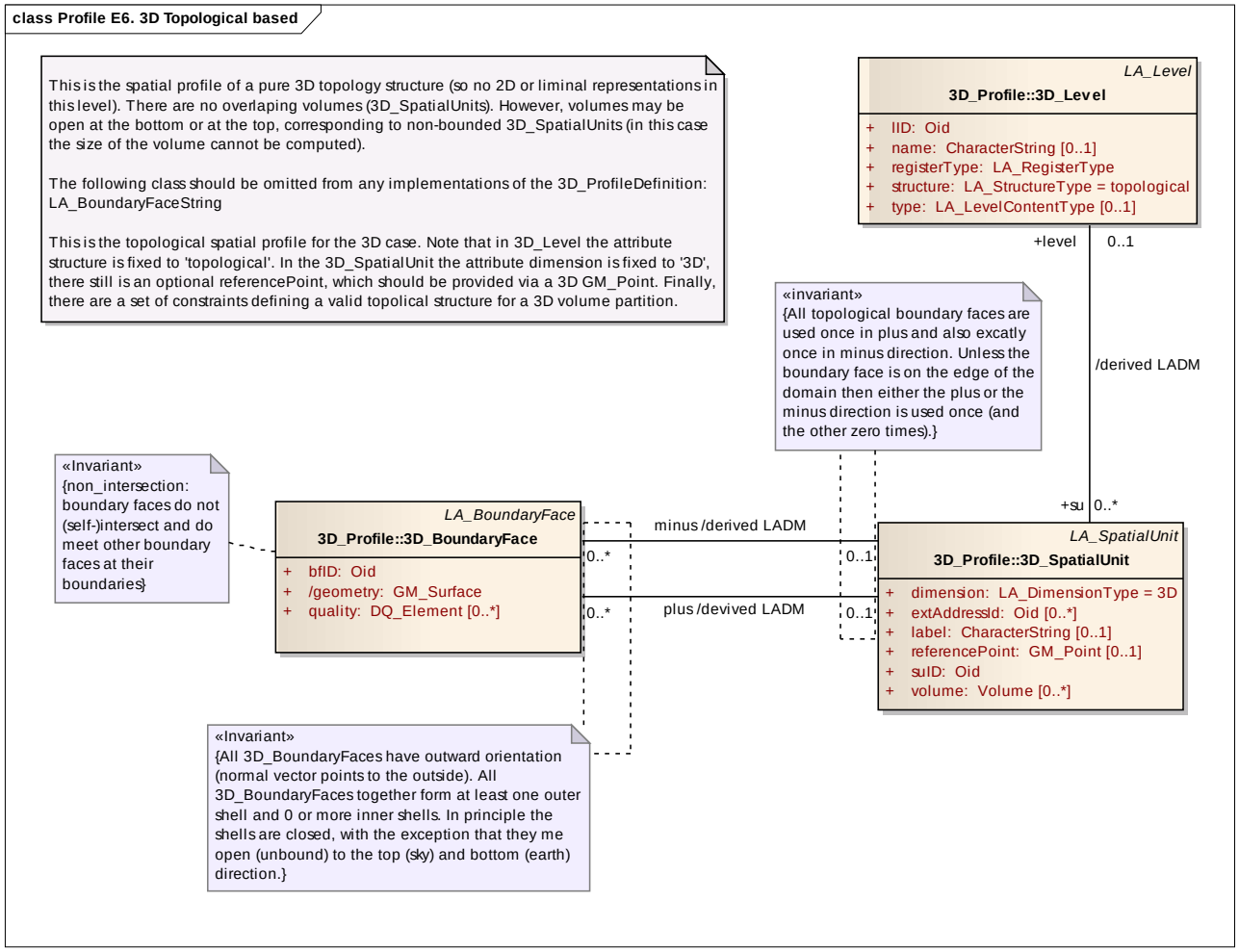
Profile E3. 2D Unstructured (line) based



Profile E4. 2D Polygon based



Profile E5. 2D Topological based

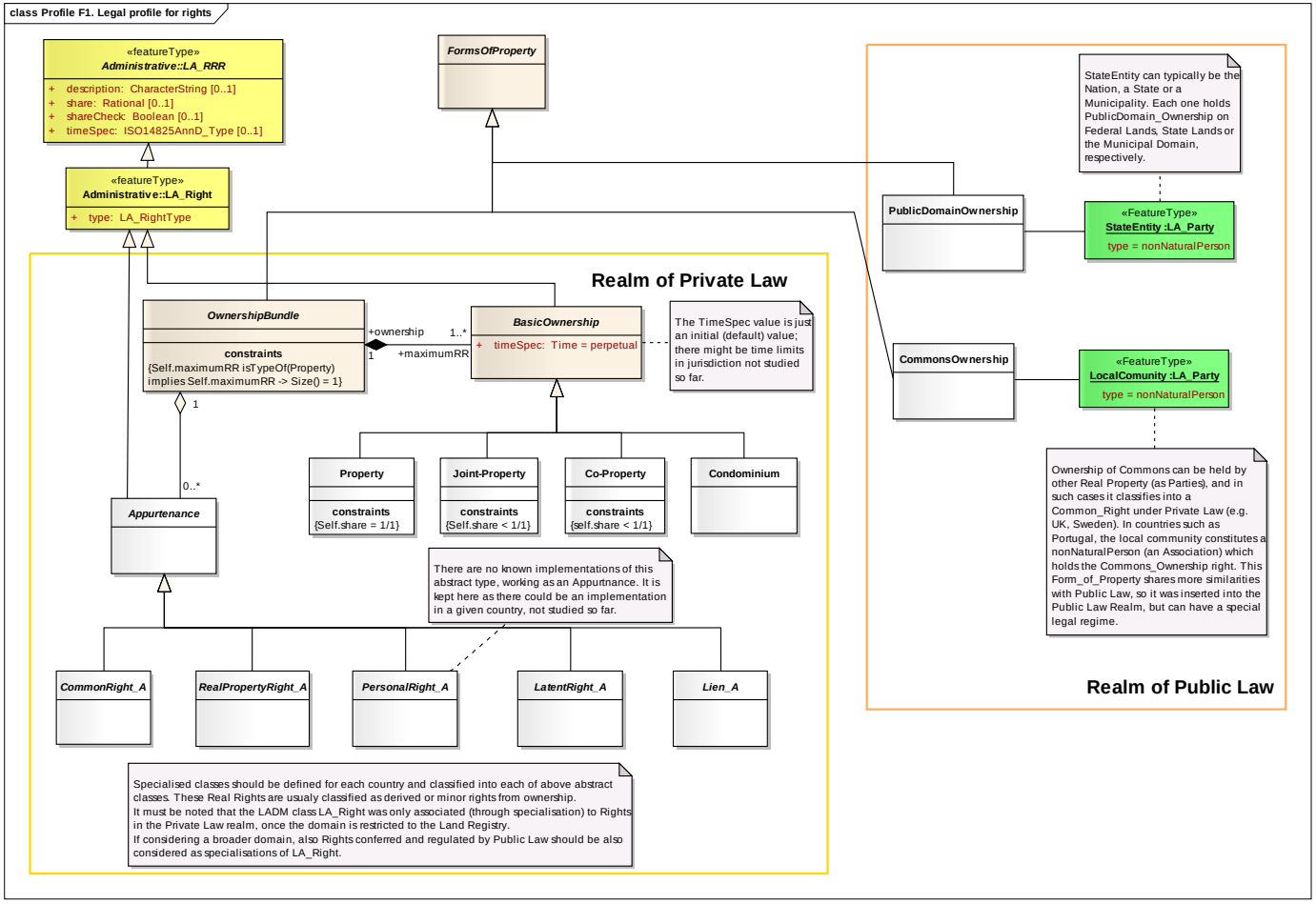


Profile E6. 3D Topological based

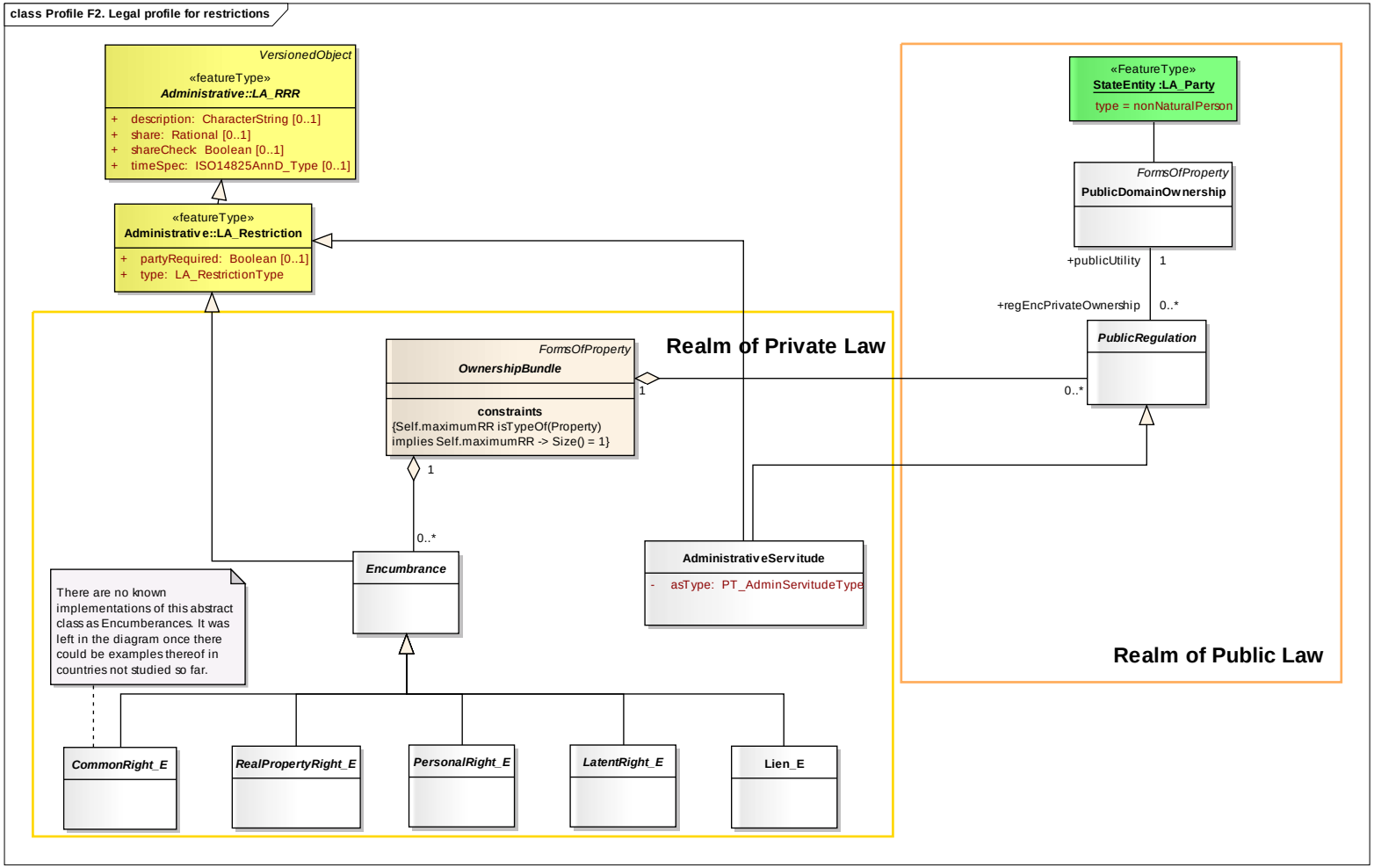
Annex F. Legal Profiles (informative)

In this Annex three legal profiles are shown:

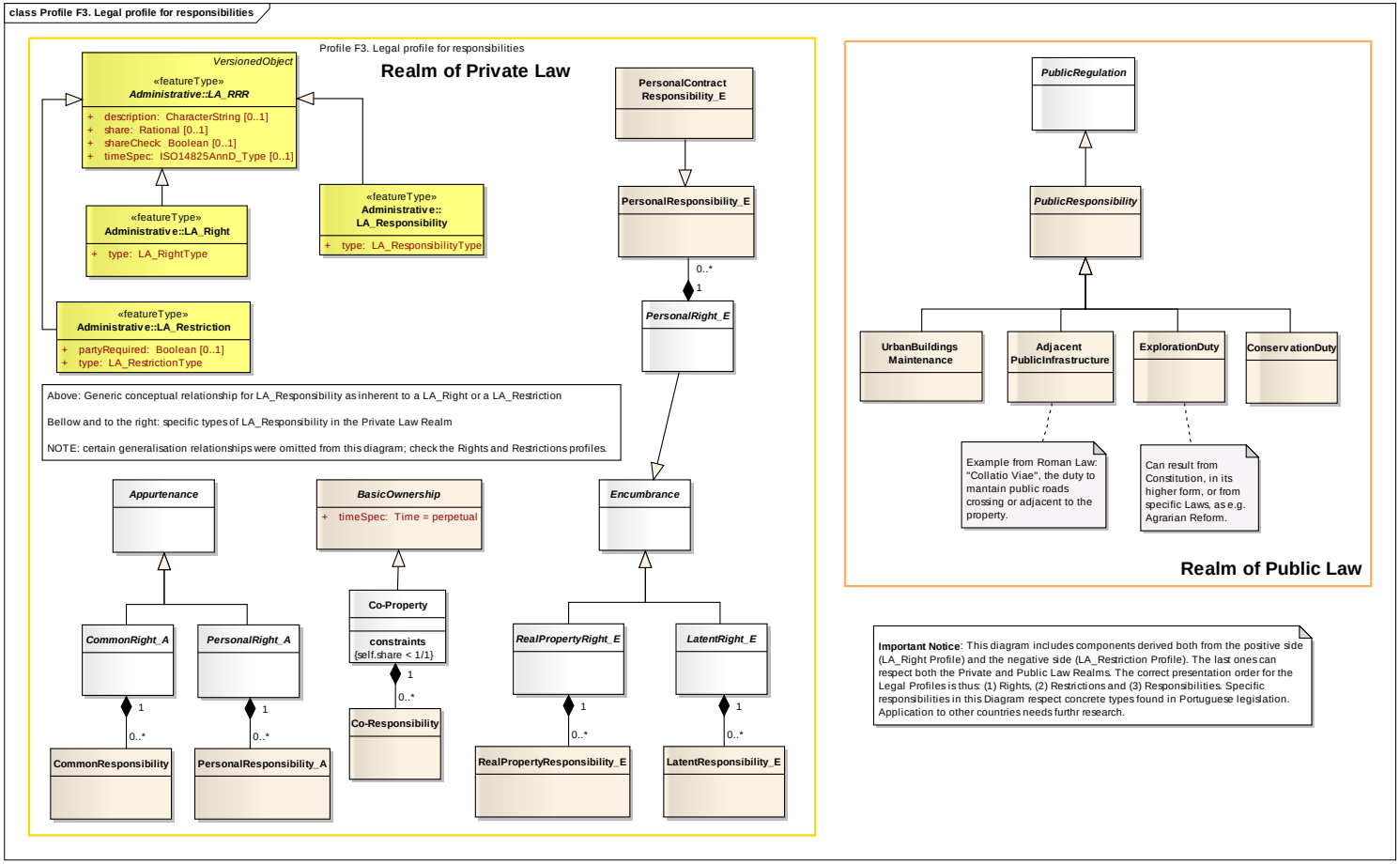
- a legal profile for rights (Profile F1)
- a legal profile for restrictions (Profile F2)
- a legal profile for responsibilities (Profile F3).



Profile F1. Legal profile for rights



Profile F2.
Legal profile for restrictions



Profile F3.
Legal profile for responsibilities

Annex G. LADM and INSPIRE (informative)

For cross-border access of geo-data, a European metadata profile based on ISO standards is under development using rules of implementation defined by the Infrastructure for Spatial Information in the European Community – INSPIRE (INSPIRE, 2007). For actual data exchange, the INSPIRE implementing rules will further define harmonized data specifications and network services. This is complemented with data access policies and monitoring and reporting on the use of INSPIRE. *Cadastral parcels* is one of the harmonized data sets (INSPIRE, 2009). Cadastral parcels in INSPIRE should serve the purpose of generic information locators for environmental applications, i.e. searching and linking other spatial information.

The INSPIRE Directive requires to take existing standards into account (article 7 of the Directive). Once adopted, the ISO 19152 standard should be taken into account whether there are requirements and consensus to extend Data Specification for Cadastral Parcels. In case of LADM, there was an excellent opportunity as both INSPIRE Cadastral Parcels (CP) and LADM where under development at the same time. Through joint work between the INSPIRE Thematic Working Group CP (TWG CP) and the LADM Project Team this has been achieved. This ensured consistency between INSPIRE and LADM, and resulted in a matching of concepts and compatible definitions of common concepts. Of course it must be remembered that there are differences in scope and targeted application areas; e.g. INSPIRE has strong focus on environmental users, while LADM has a multi-purpose character (supporting legal security, taxation, valuation, planning, etc.) and LADM is supporting both data producers and data users in these various application areas. Also, LADM has harmonization solutions for rights and owners of 3D cadastral objects (such as building units or networks), which are currently also outside the scope of INSPIRE CP. However, through the intensive cooperation, it is now made possible that a European country may be compliant both with INSPIRE and with LADM. Further, it is made possible through the use of LADM to extend INSPIRE specifications in future, if there are requirements and consensus to do so.

In order to 'prove' the compatibility, Figure G1 shows the LADM-based version of INSPIRE cadastral parcels, explicitly indicating how the INSPIRE development fits within the LADM and that there are no inconsistencies. In selecting relevant classes from LADM, using inheritance, adding attributes and constraints it has been possible to express the INSPIRE cadastral parcels data set consistent with LADM. In INSPIRE context four classes are relevant:

- LA_SpatialUnit (with LA_Parcel as alias) as basis for CadastralParcel
- LA_BAUnit as basis for BasicPropertyUnit
- LA_BoundaryFaceString as basis for CadastralBoundary
- LA_SpatialUnitGroup as basis for CadastralZoning.

The LADM attributes inherited by INSPIRE can have a more specific data type or cardinality in INSPIRE (compared to LADM). This has been included in the diagram. This implies that an optional LADM attribute [0..1], might not occur in INSPIRE as the cardinality can be set to 0; e.g. nationalVolume. This also implies that an optional LADM attribute [0..1], might be an obligatory attribute in INSPIRE; e.g. label. Further, INSPIRE specific attributes are added to the different classes. Figure G1 looks a bit more complicated as the normal INSPIRE CP UML class diagram, because it is showing the different LADM parent classes and the refinement of the different attribute types (but the resulting model is the same).

Once the implementing rules will be adopted and the INSPIRE cadastral parcels data specification is final, this Annex will contain two UML class diagrams: one showing how the INSPIRE cadastral parcels can be derived from the corresponding LADM classes and one diagram showing the result (without the inheritance relationships).

It should be noted that the current scope of the INSPIRE cadastral parcels is more limited than LADM; e.g. it does not include rights, restrictions and responsibilities.

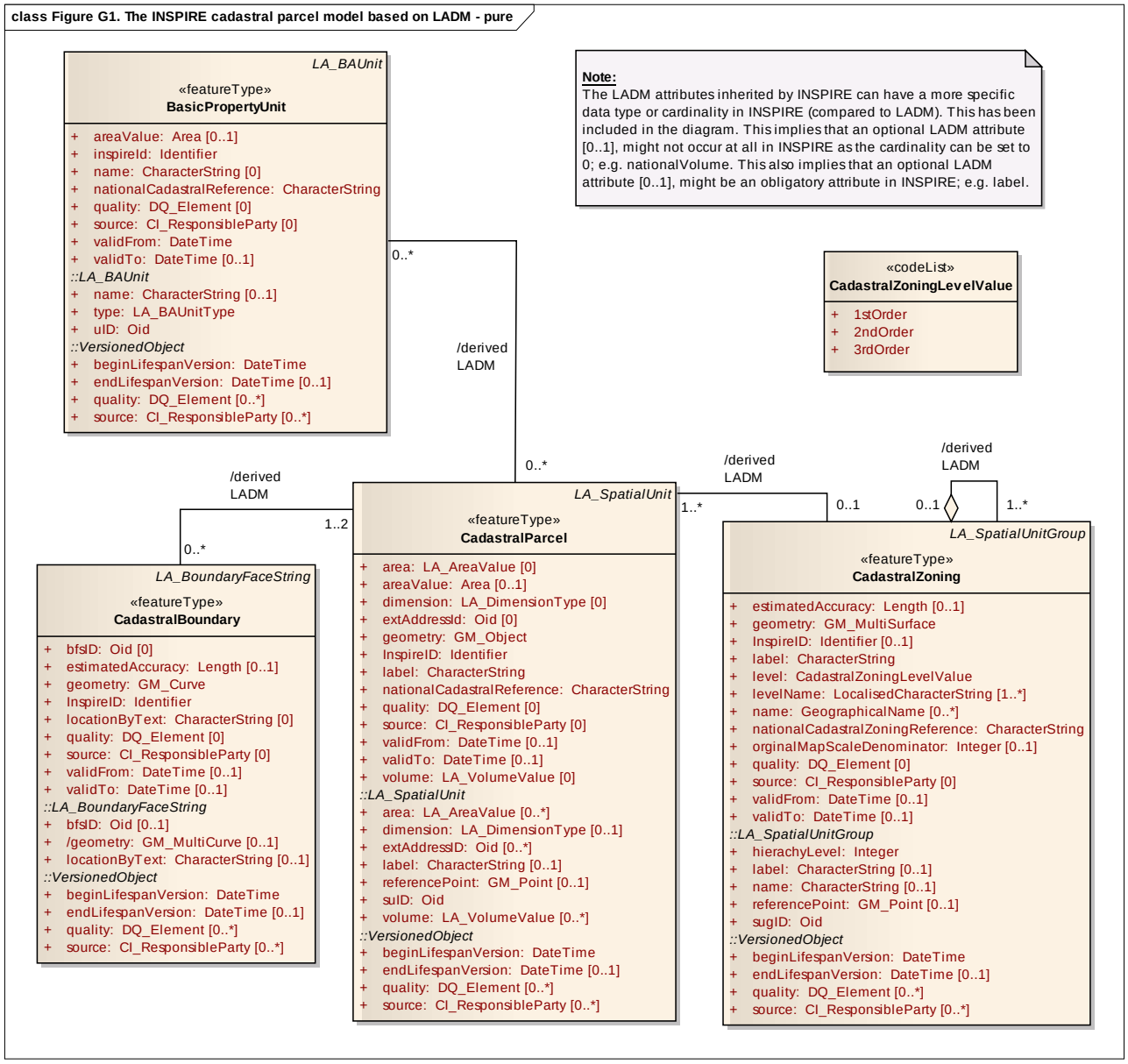


Figure G1. The INSPIRE cadastral parcel model based on LADM

Annex H. LADM and LPIS (informative)

H.1. The integration of LADM with European Land Parcel Identification Systems (LPIS)

One of the aspects of the Common Agricultural Policy (CAP) of the European Union is to focus on the management of subsidies to the farmers. For this purpose, member states have established Integrated Administration and Control Systems (IACS), including Land Parcel Identification Systems (LPIS) as the spatial component. The LPIS as a concept was developed already in 1992, when the need for identification of the agriculture parcels to support IACS emerged. At that time, the data model was purely alphanumerical without any geospatial reference. It was in the Council Reg. No 1593 (2000) that the spatial LPIS based on Geographic Information System (GIS) was promoted. Five years have been given to the member states to establish LPIS in digital and geo-referenced format. Thus, the first year of operational GIS-based LPIS was 2005. Although the regulatory requirements were unique across the sector, the particular implementations were a subject of the member states. In fact, during the development stages of different LPISs in different member states, the use of Land Administration (LA, or Cadastre) data, as well as large scale topography data, were on the agenda for a considerable while (UN/ECE,2004). In the following example a data model is designed that implies the collaboration or integration of LADM and LPIS. The standardization initiative in the area of LPIS (Sagris and Devos, 2008; CCM, 2009) by the Joint Research Centre (JRC) of the European Commission is used in this example in order to represent potentials for integration/collaboration between LADM and LPIS.

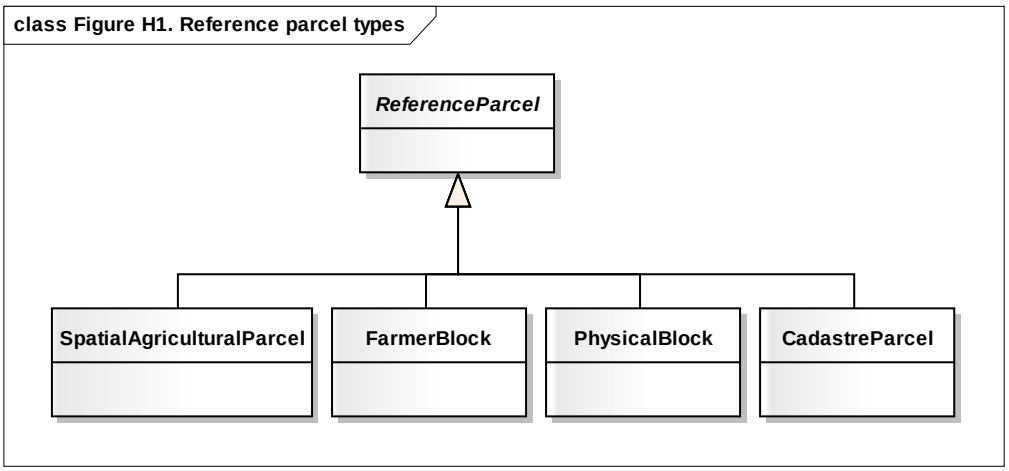


Figure H1. Reference parcel types

A declared agricultural parcel is a key concept applied in relation to area-based payments, which determines the subject of the aid application, geographic location and extent (area) of agricultural activity. The declared agricultural parcel is a subject of the payment calculation as well as for administrative control. Due to the dynamic nature of agricultural activities, declared agricultural parcel can be unstable over time and space (crop rotation, out of use, aggregation or subdivision of fields, different extent of use, conditions for eligibility for payments etc.). Therefore, the reference parcel (RP) is used as basic unit of LPIS for purpose of identification of the declared agricultural parcels where one RP can contain one or many (1..*) declared agricultural parcels. The EU regulations specify that reference parcel can be either cadastral parcel or production block (see Figure H1). In the end some member states decided to build their systems as close to declared agricultural practice as it possible and use reference unit which contains only one spatial agricultural parcel.

The main difficulties of Cadastral parcel as reference for subsidies' application are that (i) it contains non-agricultural land, so area eligible for payment can not be directly determined, and (ii) that boundaries of agricultural activity are out of LA scope and their maintenance via cadastral update cycle is very complicated. Therefore in Section H.2 the concept of SubParcel is introduced, which plays the role of a reference parcel (and as glue between LADM and IACS/LPIS).

H.2. A data model for the integration of LADM and LPIS

In the UML class diagrams, current LADM classes are used with or without small changes in their attributes or they are extended with new classes, and IACS/LPIS classes are shown in a single colour (grey).

H.2.1 Basics of LPIS Core Model (LCM)

LPIS Core Model (LCM) has been developed by the Agriculture unit of the EC Joint Research Center (JRC). The intention with this model is to extract general classes from functional LPIS systems (or from a functional system) and test them for conformance with the EU Regulations; therefore the model does not cover every aspect of the LPIS. Member State experts could extend the boundaries of the LCM to fit particular needs of national implementations. Figure H2 represents the logical business model of the main concepts of the LCM. All basic concepts are represented as classes.

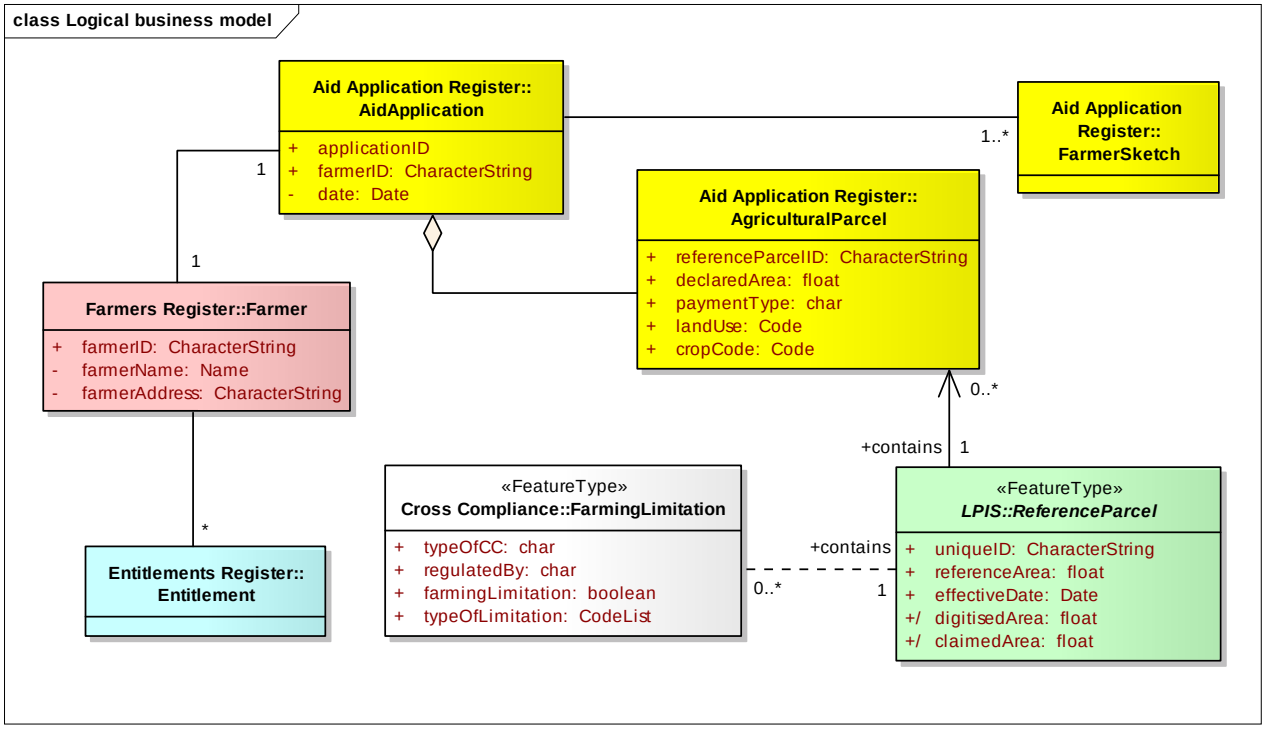


Figure H2. The core (classes) of the LCM

H.2.2 Integration of LCM and LADM Basic Classes

H.2.2.1 Spatial classes

The class LA_SpatialUnit is one of the core classes of LADM. LADM also provides the functionality of administrative grouping the LA_SpatialUnits with the class LA_BAUnit through which the legal facts (right, restrictions, responsibilities in LA_RRR) are attached. The specialized class LA_Parcel is inside the scope and the other specialized classes of LA_SpatialUnit are outside of the scope of the LADM and LPIS integration (LA_Building, LA_LegalSpaceBuildingUnit, LA_LegalSpaceNetwork) as is the hierarchical grouping in LA_SpatialUnitGroups (sections, municipalities, etc.); see Figure H3. For a meaningful,

comparable and standardized classification of land, at least for the case of cadastral parcels as agricultural reference parcel, SubParcel class is designed as a part of cadastral parcels in the model. SubParcel has composition association to LA_Parcel. In the SubParcel class, the attribute typeSubParcel is designed to store different types of SubParcel. These are defined in the code list SubParcelType (Figure H3). One important consideration is that the boundaries of the defined classes should be stable over time. Otherwise, the update and maintenance procedures will definitely be a burden.

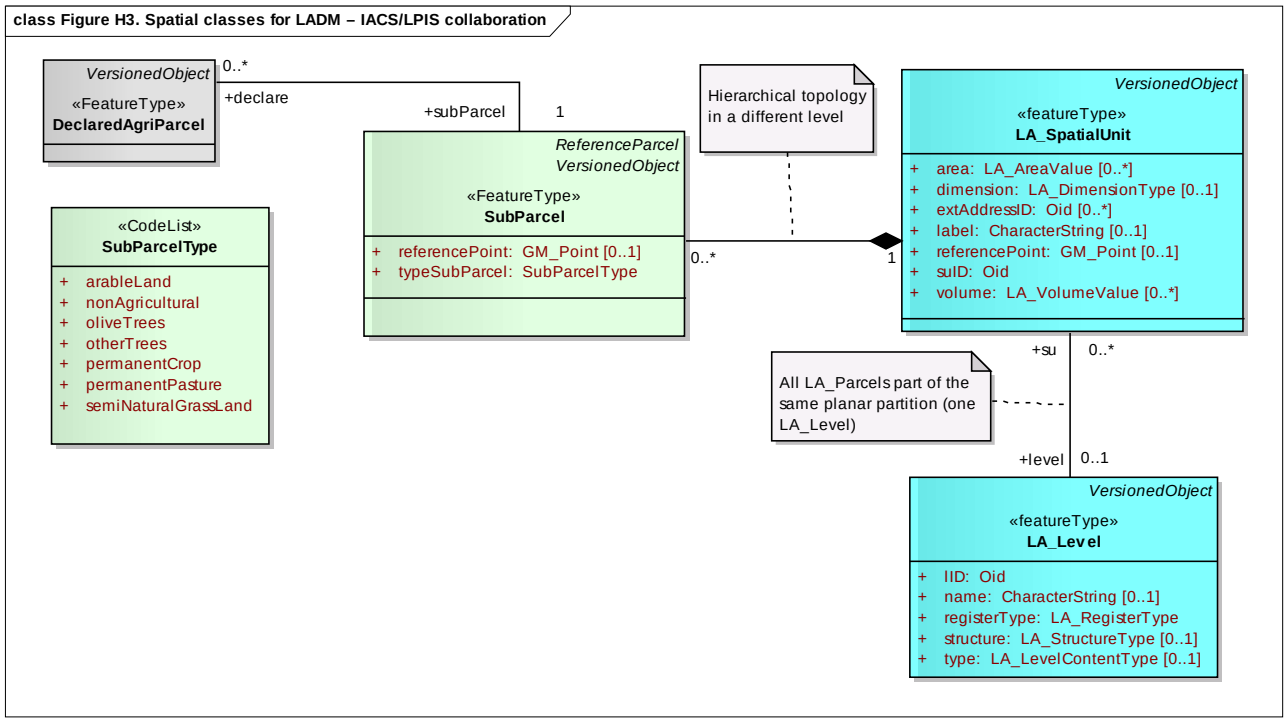


Figure H3. Spatial classes for LADM – IACS/LPIS collaboration

H.2.2.2 Administrative classes

LA_Party (person), Farmer, Right/Restriction/Responsibility (LA_RRR), YearlyAidApplication, YearlyFarmerSketch, DeclaredAgriParcel are the basic classes designed to manage administrative data in the model (Figure H4). LA_Party and LA_RRR are two core classes coming from LADM. Other classes are designed for the description of LPIS administrative data.

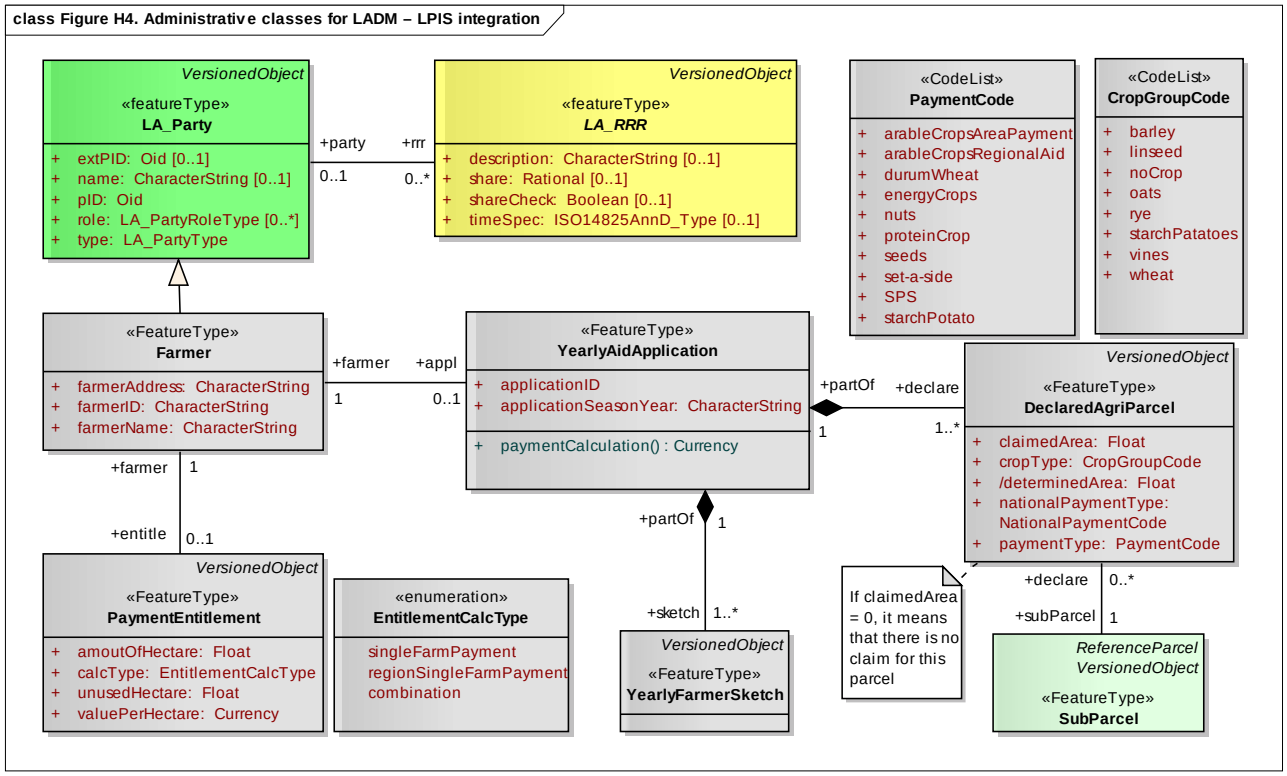


Figure H4. Administrative classes for LADM – LPIS integration

Farmer class is designed as a specialization of LA_Party class in order to handle the attributes specific to farmers. Farmers may apply for agricultural subsidies every year. To handle the application information of farmers, YearlyAidApplication class is designed. Aid applications submitted by farmers must be accompanied by farmer declarations which describe each piece of land used by farmer for agricultural activities and farmers' sketch. Therefore there are two corresponding classes (DeclaredArgiParcel and YearlyFarmerSketch) composing the YearlyAidApplication (a LA_Source) in the model. To represent their entitlement rights, PaymentEntitlement class is introduced in the model. In the sketch which farmers must provide together with their applications, they indicate the boundaries of their agricultural parcels. They may use one single agricultural parcel or many of them. They may draw the boundaries of their land in separate sketches for each piece of land. Some grouping is also possible depending on their location and the scale of the sketch. Aid applications submitted by farmers must be accompanied by farmer declarations which describe each piece of land used by farmer for agricultural activities. These declarations are subject to agricultural subsidies after some control processes are carried out. Farmer declarations are represented by DeclaredAgriParcel in the model. It is designed as a part of YearlyAidApplication class because this class can not be without any aid application.

H.3. Special issues for the integration of LADM and LPIS

Farmer is defined in article two of the Regulation EC No 1782/2003 as a natural or legal person or a group of natural or legal persons. This definition of person can be represented by LA_Party classes designed for LADM. In Figure H5, the classes in green are LADM person classes. LA_Party is the main class which represents natural person and non natural person, and also groups of natural and non natural persons via LA_GroupParty class. So, LADM person classes have the functionality of representing farmers as all kinds of persons. However, a new class Farmer is designed to represent the attributes which are specific only to farmers. Currently in the model, only two specific attributes. One is farmerID which indicates that the person is a farmer. The other is farmerAddress which includes up-to-date address information.

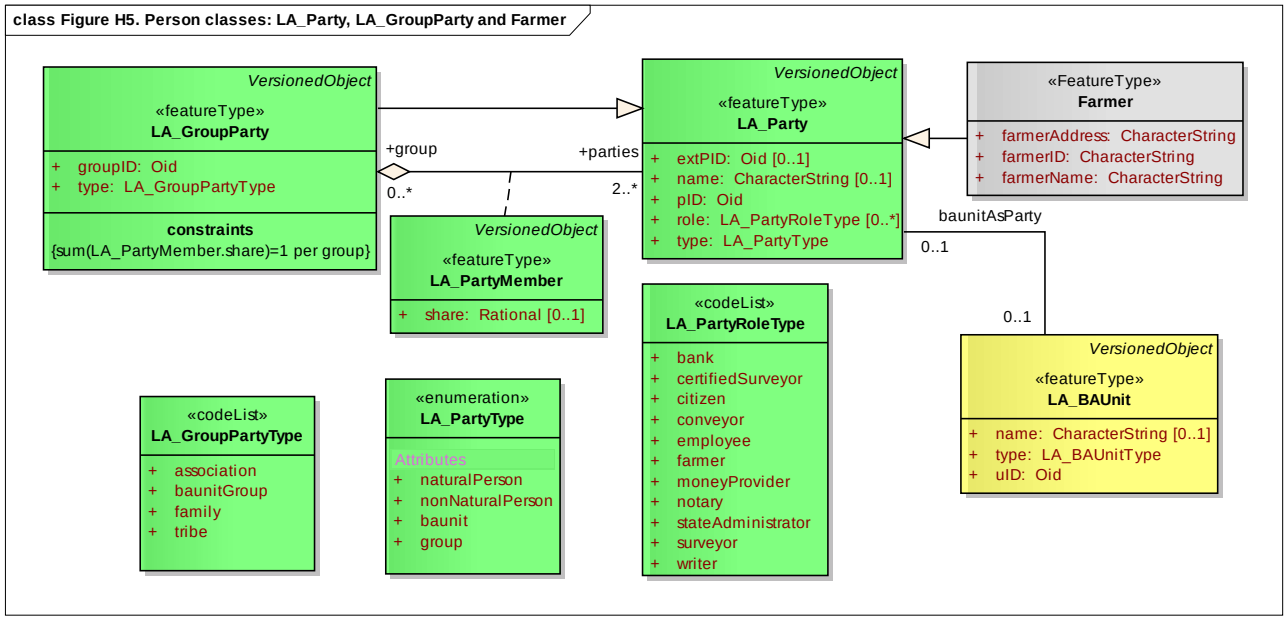


Figure H5. Person classes: LA_Party, LA_GroupParty and Farmer

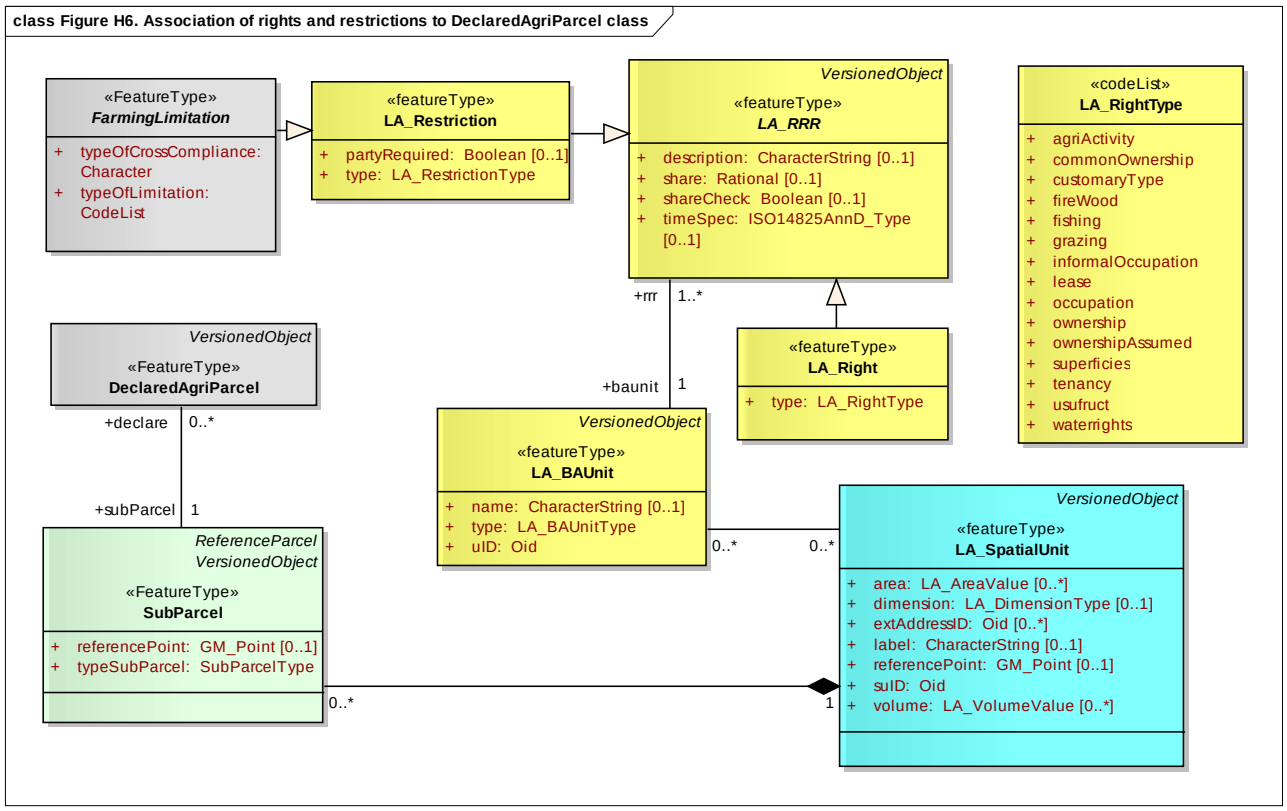


Figure H6. Association of rights and restrictions to DeclaredAgriParcel class

In LADM, LA_RRR class has three main types of specialization classes – LA_Right, LA_Restriction, and LA_Responsibility. In the collaboration model for LPIS integration, farming rights are represented by LA_Right class and some of farming limitations are represented by FarmingLimitation class as a

specialization of LA_Restriction class (Figure H6). The only right IACS/LIPS is about is right to be paid (entitlement). It is associated with Farmer and via YearlyAidApplication and DecalredAgriParcel to SubParcel. It is not related directly to the whole LA_Parcel.

H.4. Discussion

This Annex shows that several aspects of LADM can be used in the integration of different LPIS set-ups in different member states of the European Union. Several other important aspects are not mentioned here but can be found in (Inan et al, 2008).

There has been a common understanding that the LPIS deals with farmers (users of land) and the Cadastre (or the LAS) deals with owners and they may not be the same person. Unlike such kind of common understanding, LASs, by definition, deal with a wide range of information related to land including ownership, land use rights (right holders of registered properties), farming rights, restrictions, responsibilities etc. We can also call such kind of a LAS as multi purpose cadastre. However, it is a fact that conventional LASs as legacy systems are currently not always capable of administering all kinds of land related rights. This is why LASs are generally underestimated by third parties. Therefore, registration of farmers and farming rights in a LAS has been regarded as an obstacle when compared with LPIS. In fact, a farmer is a person who does some kind of agricultural activity on some piece of land. Farmers may own some land for their activities. They may lease and/or get some kind of consent from others for another piece of land.

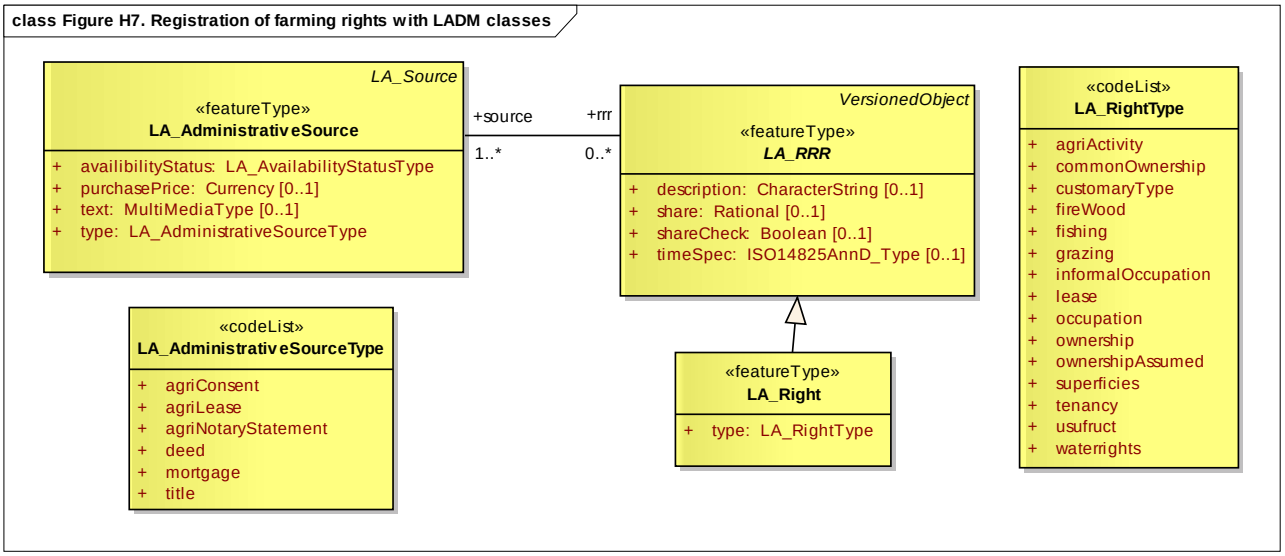


Figure H7. Registration of farming rights with LADM classes

In this example, farming rights are designed as part of LAS with a few extensions in code lists (LA_RightType and LA_AdministrativeSourceType) with attribute values for attributes of some LADM classes (see Figure H7). The idea is that this will enable the application of an integrated solution for the management of land use rights both for LAS and LPIS applications.

In order to try to design and test properly the model presented above, a modeling of the use cases (from the business and system point of view) should be elaborated, including Activity diagrams of the processes and workflows.

Annex I. 2D and 3D Representations of Spatial Units (normative)

2D and 3D representations of spatial units use boundary face strings and boundary faces as key concepts. Coordinates themselves are rooted in points (mostly after geo-referencing, depending on the data collection method used) in the Surveying Package. As pointed out by (Stoter, 2004), in many countries a 2D description may be interpreted as a 3D prismatic volume with no upper and lower bound.

Using this interpretation, 2D and 3D descritions can be unified (Thompson, 2008). The boundaries in the 2D representations are called boundary face strings: they use a normal GM_MultiCurve (linestring) for storage, but this implies a series of vertical boundary faces. See Figure I-1.

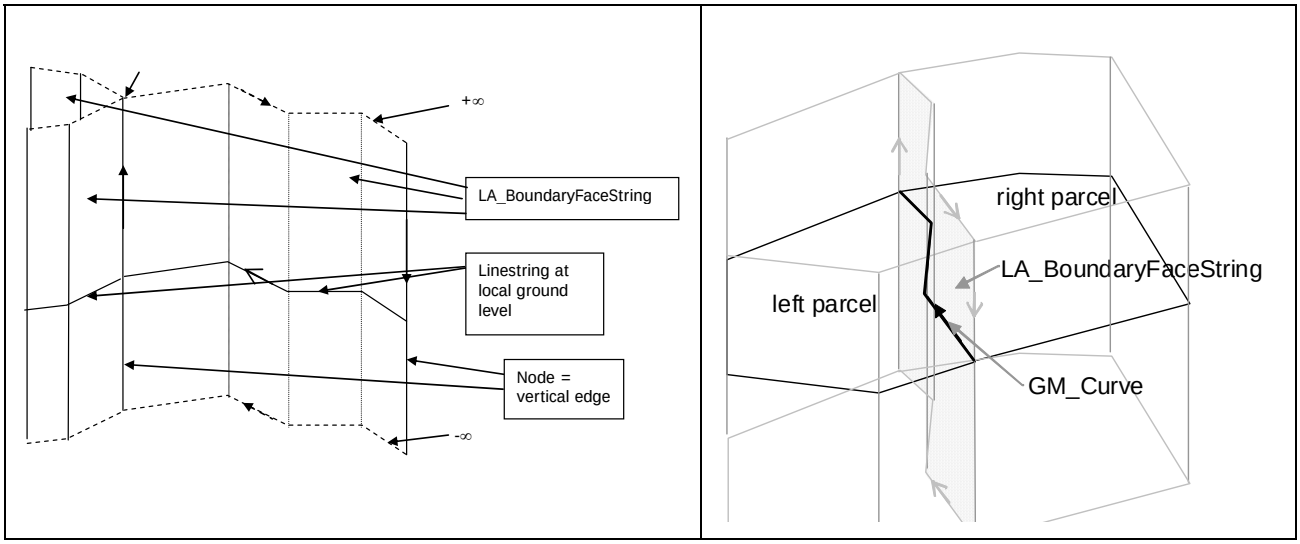


Figure I-1. Boundary face string concepts (*Left*). Spatial units defined by boundary face strings (*Right*)

For true 3D representations that also have non-vertical boundary faces, the class LA_BoundaryFace is introduced (this allows the representation of a space or volume like an invertred cone, where the top is wider than the bottom. This is realized with a boundary face with the GM_Surface attribute that may be curved). A liminal spatial unit (that is a spatial unit on the threshold of 2D and 3D) has a combination of boundary face strings and vertical boundary faces.

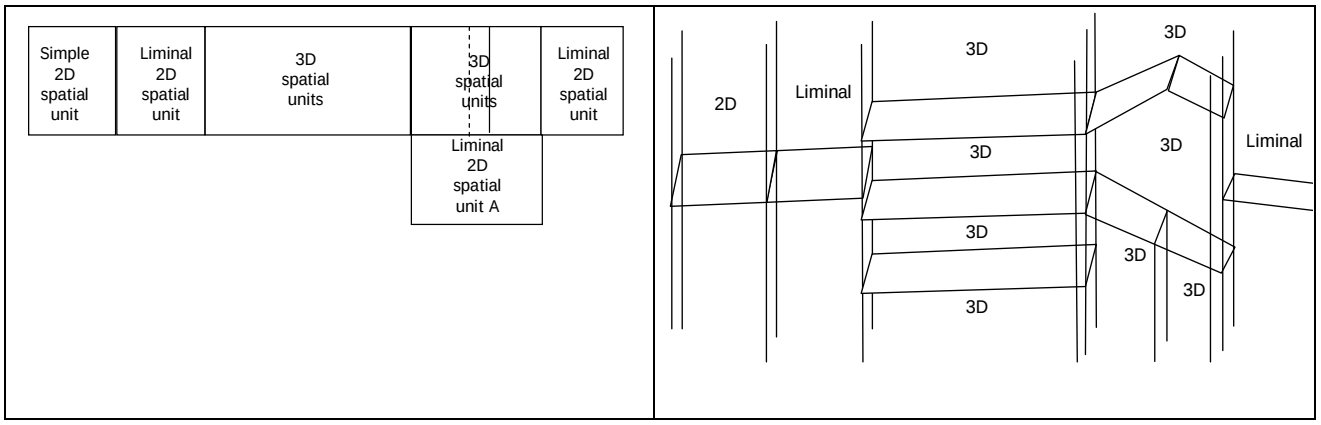


Figure I-2. Top view of mixed 2D/3D representations (Left). Side view showing the mixed use of boundary face string and boundary face to define both bounded and unbounded 3D volumes (Right)

The vertical boundary faces shall dissolve into boundary face strings (when common pairs of edges are removed). The boundary faces shall be completely defined from an (undefined) upper bound to an (undefined) lower bound. See Figure I-2.

This method is used for a 2D spatial unit which is adjacent to a 3D spatial unit, with a split in the shared vertical boundary face. The attribute ‘dimension’ in LA_SpatialUnit indicates if it concerns a 2D, liminal or 3D description of a spatial unit. E.g. 3D can be applied for a mining cadastre, or it can be applied for individual spatial units.

In addition to these principles, there are five levels of spatial representation identified (indicated by the ‘structure’ attribute in LA_Level):

- point based (point spatial unit). A point spatial unit is used when the only information about its location is a pair of coordinates of a single point within its area (or volume). The attribute ‘referencePoint’ in LA_SpatialUnit is used to record this location, which may carry a z-value
- text based (text spatial unit). A text spatial unit is used when its definition is entirely by descriptive text. The spatial unit is accompanied by one or more boundary face strings, each of which carries a block of free text in the ‘locationByText’ attribute in LA_BoundaryFaceString. No geometry is used with this type of boundary face string. The ‘referencePoint’ is optional, and may be used as a specific labelling point, and can also carry a z-value
- unstructured (line) based (line spatial unit). A line spatial unit (‘spaghetti’) is used when its description is allowed to have inconsistencies such as hanging lines and incomplete boundaries. For the 2D case, the full length boundary face strings are stored once only, not broken at the corners of the spatial units. The spatial units are linked to the boundary face strings that define them. For the 3D case, at least one boundary face is included (and this can intersect other boundary face strings and boundary faces)
- polygon based (polygon spatial unit). A polygon spatial unit is used when every spatial unit is recorded as a separate entity. There is no topological connection between neighbouring spatial units (and no boundaries shared), and so any constraint enforcing a complete coverage shall be applied by the originating and receiving software. In the 2D description there is exactly one link to a closed boundary face string instance for every ring of the polygon (or set of boundary face strings that form together a closed ring). A polygon spatial unit used in a 3D description uses at least one (non-shared) boundary face.
- topological based (topological spatial unit). A topological spatial unit is used when spatial units share boundary representations. A topological spatial unit is encoded by reference to its boundaries, with the common boundary between two spatial units being stored once only. Thus there is a topological connection between neighbours. In case of a 2D description, boundary face strings are used forming closed loop(s) and these boundary face strings have left and right references to the spatial units. In case of a 3D description, at least one boundary face with left/right information is included.

Mixed representations are also possible, because a boundary face string can be defined either by a geometry, or by a free text block. It is possible for a spatial unit in any form of encoding to be specified by geometry on some boundary faces, while text on others. It is also possible to topologically encode text based spatial units; for example, part of a boundary can be defined by text (e.g. “along the natural shoreline”), while other boundaries can be defined by coordinates. The boundary face string that defines the shoreline can be used in the definition of a water feature on the other side of the boundary, thus ensuring topological correctness without the need for coordinate values. Again, this may occur in both 2D and 3D.

It must be stressed that the above applies to any type of spatial unit (including the ones that are used for recorded spaces around buildings and networks, or for servitudes). To organize the instances, there is the concept of a level model. This is especially relevant for the topology based spatial units, but also applies to other types. For example, there may be a base level (Level 1) with ownership spatial units, which are topologically defined and there may be an additional level (Level 2) with polygon based spatial units representing servitudes. The concept of levels may also be used in other situations. For example, Level 1 for

present ownership and Level 2 for pre-war ownership. A 3D example would be Level 1 containing ownership (2D, liminal and 3D topological spatial units) and Level 2 would contain ownership of ‘legal space’ around networks crossing many other spatial units (from which the network space can be subtracted); see Figure I-3.

The 2D or 3D (topology) structures shall be valid at every moment in time. With topological spatial units, there are never gaps or overlaps in the partition. However, boundaries belonging to different time spans (defined by versions) may cross. The temporal topology shall also be maintained: that is, no time gaps or overlaps must occur in the representations. Therefore, the structure is based on spatio-temporal topology. Current land administration systems, based on 2D topological and geometrically described spatial units, have shown limitations in defining the (2D and 3D) location of 3D constructions (e.g. pipelines, tunnels, building complexes) and in the vertical dimension (depth and height) of rights established for 3D constructions (Stoter, 2004). In LADM, 2D and 3D data are treated in a consistent manner throughout the model. It is important to realize that there is a difference between the 3D physical object itself and the legal space related to this object. LADM only covers the ‘legal space’; that is the space that is relevant for the Land Administration (bounding envelope of the object). This is usually larger than the physical extent of the object itself (for example including a safety zone).

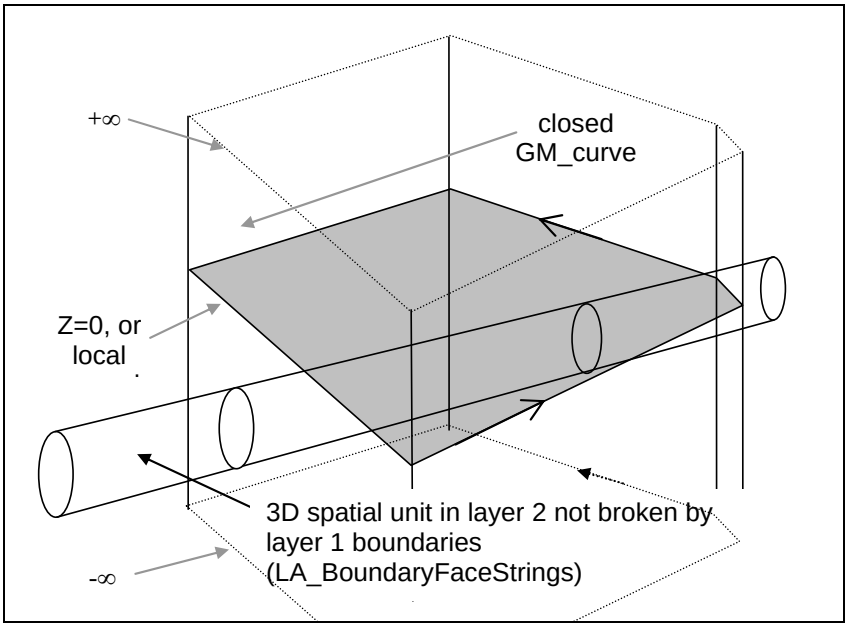


Figure I-3. Multiple levels

Annex J. Code lists, Enumerations and Data Types (informative)

Code lists are used to describe a more open and flexible enumeration. Code lists are useful for expressing a long list of potential values. If the elements of the list are completely known, an enumeration should be used; if the only likely values of the elements are known, a code list should be used. The code lists included in LADM aim to allow the use of local, regional or national terminology. Figure J1, Figure J2, and Figure J3 show possible examples of these code lists, together with enumerations and data types.

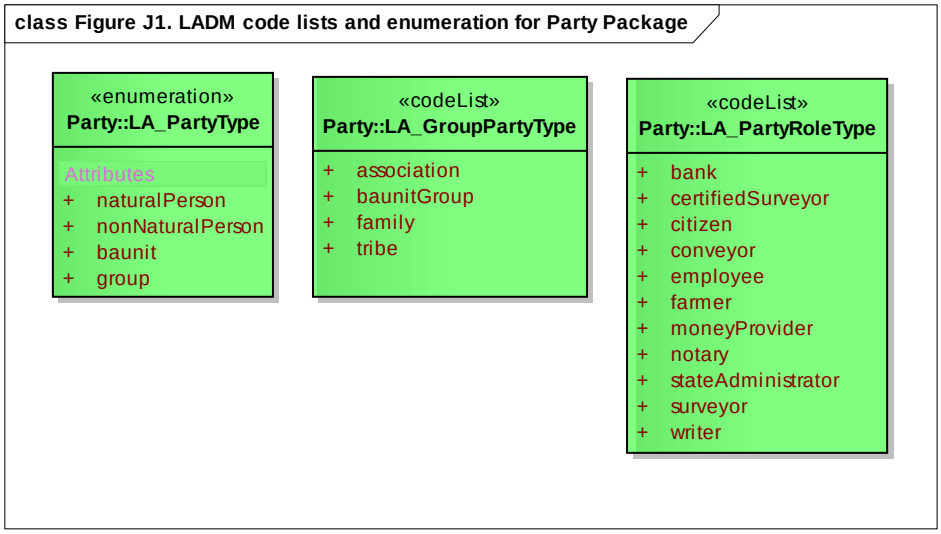


Figure J1. LADM code lists and enumerations for Party Package classes

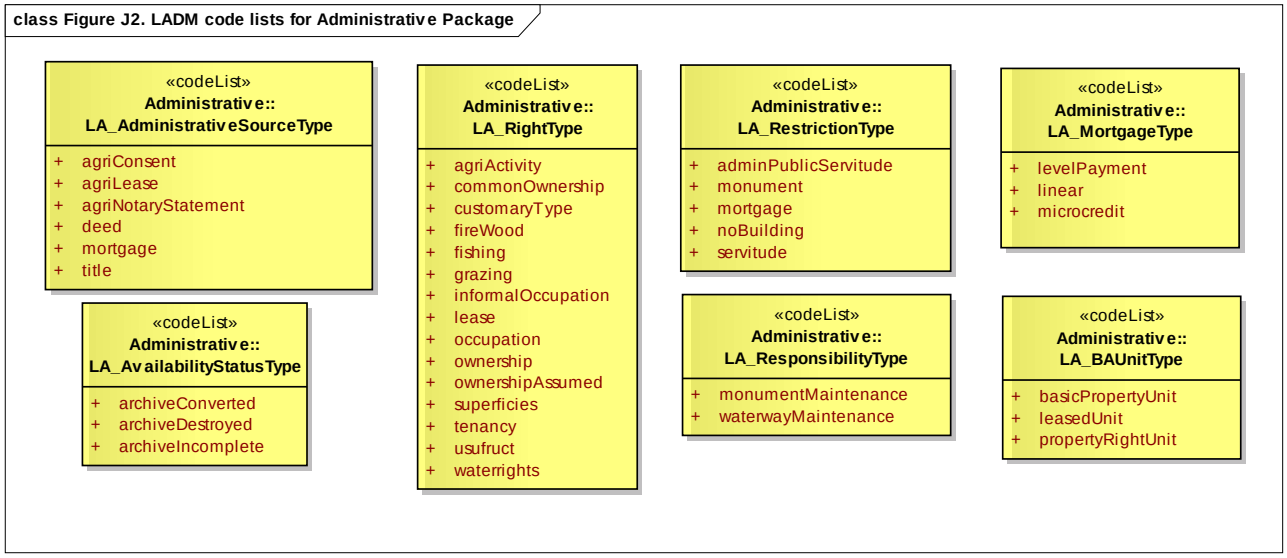


Figure J2. LADM code lists for Administrative Package classes

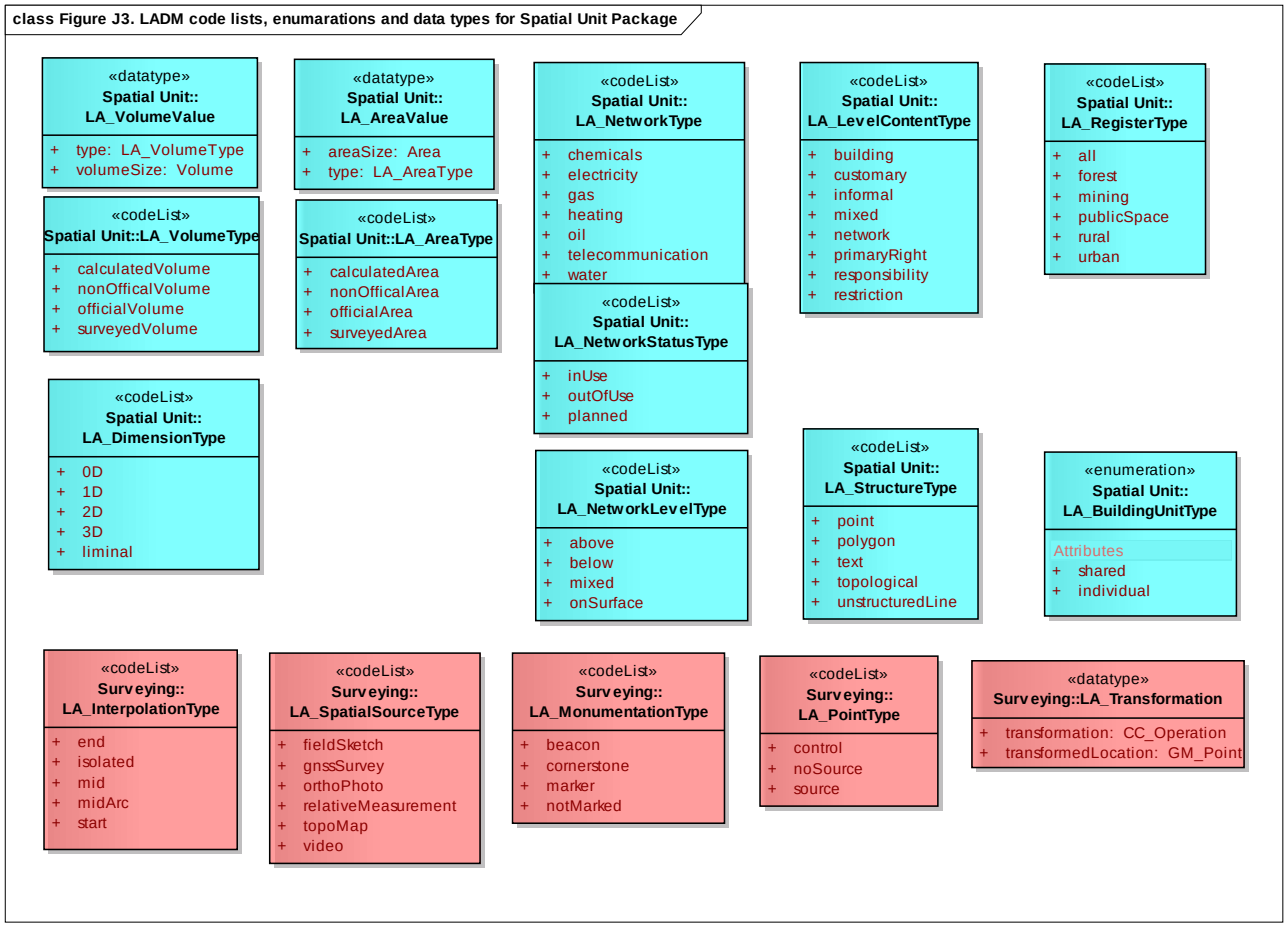


Figure J3. LADM code lists, enumerations, and data types for Spatial Unit Package and Surveying Subpackage classes

Annex K. External Classes (informative)

Introduction

The construction of external databases with party data, address data, valuation data, land use data, land cover data, physical network data, and taxation data is outside the scope of LADM. However, LADM provides 'blueprint' stereotype classes for these data sets that indicate what data set elements LADM expects from these external sources, if available.

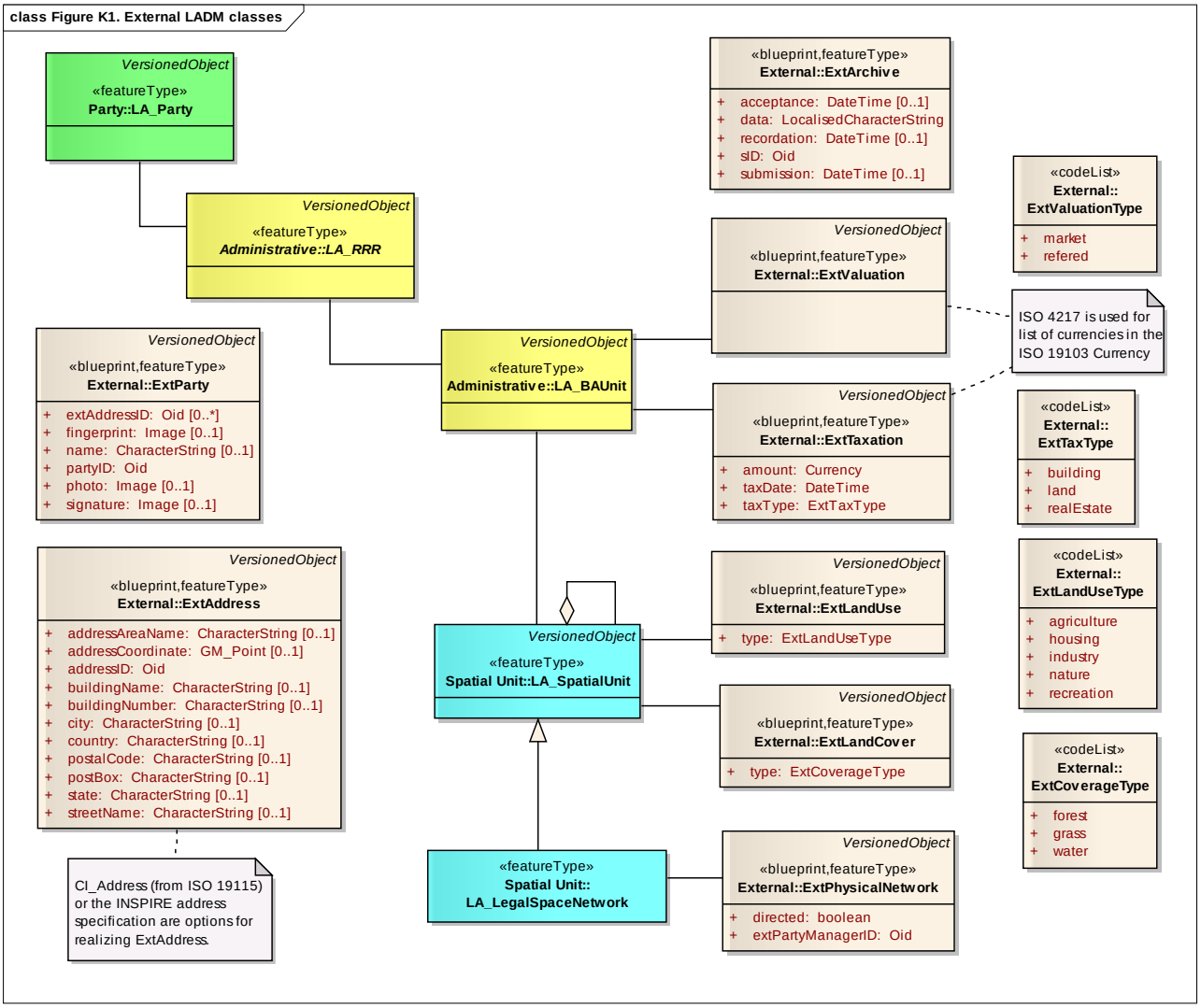


Figure K1. External LADM classes

ExtParty

Class ExtParty is a 'blueprint' class for an external registration of parties. See Figure K1.

The attributes of ExtParty are:

- extAddressID: the identifier pointing to the external address
- fingerprint: the fingerprint of the external party
- name: the name of the external party

- partyID: the identifier of the external party
- photo: the photo of the external party
- signature: the signature of the external party.

ExtAddress

Class ExtAddress is a ‘blueprint’ class for an external registration of addresses (an address being a direction for finding some location). See Figure K1.

The attributes of ExtAddress are:

- addressAreaName: the address area name of the external address
- addressCoordinate: the coordinates of the external address
- addressID: the identifier of the external address
- buildingName: the building name of the external address
- buildingNumber: the building number of the external address
- city: the city of the external address
- country: the country of the external address
- postalCode: the postal code of the external address
- postBox: the post box of the external address
- state: the state of the external address
- streetName: the street name of the external address.

NOTE. INSPIRE address specifications may also be used.

ExtTaxation

Class ExtTaxation is a ‘blueprint’ class for the external registration of taxation data. See Figure K1.

The attributes of ExtTaxation are:

- amount: the amount of taxation
- taxDate: the date of taxation
- taxType: the tax type.

Class ExtTaxation is associated to class LA_BAUnit. See Figure K1.

ExtLandUse

Class ExtLandUse is a ‘blueprint’ class for the external registration of land use data; land use is an arrangement, activity or input people undertake in certain land cover type, to produce, change or maintain it. See Figure K1.

The attribute of ExtLandUse is:

- type: the type of land use.

Class ExtLandUse is associated to class LA_SpatialUnit. See Figure K1.

ExtLandCover

Class ExtLandCover is a ‘blueprint’ class for the external registration of land cover data; land cover is the observed (bio)physical cover on the earth's surface. See Figure K1.

The attribute of ExtLandCover is:

- type: the type of land cover.

Class ExtLandCover is associated to class LA_SpatialUnit. See Figure K1.

ExtValuation

Class ExtValuation is a ‘blueprint’ class for the external registration of valuation data. See Figure K1.

The attributes of ExtValuation are:

- value: the value of the valuation
- valueDate: the date of the valuation
- valueType: the valuation type.

Class ExtValuation is associated to class LA_BAUnit. See Figure K1.

ExtPhysicalNetwork

Class ExtPhysicalNetwork is a ‘blueprint’ class for the external registration of mapping data of utility networks. See Figure K1.

The attributes of ExtPhysicalNetwork are:

- directed: the flow direction, fixed or not
- managerID: the organization responsible for the network.

Class ExtPhysicalNetwork is associated to class LA_LegalSpaceNetwork. See Figure K1.

ExtArchive

Class ExtArchive is a ‘blueprint’ class for the external registration of sources. See Figure K1.

The attributes of ExtArchive are:

- acceptance: the date of force of law of the source by the authority
- data: the content of the source
- recordation: the date of registration (recordation) of the source by registering authority
- sID: the identifier of the source
- submission: the date of submission of the source by a party.

Code Lists for External Classes: see Figure K2)

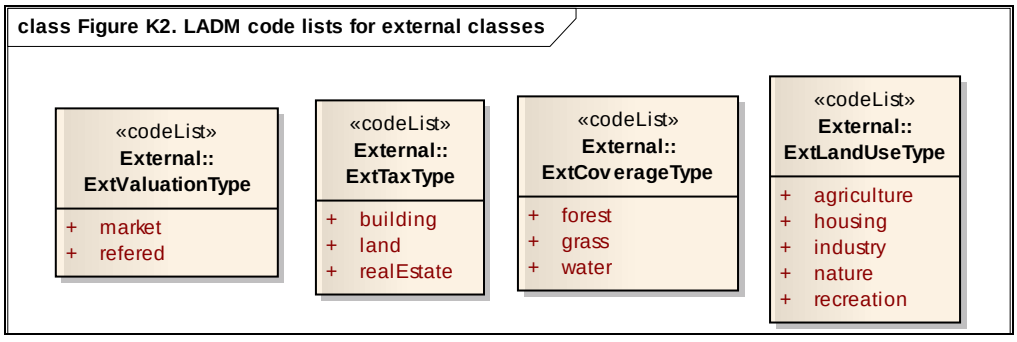


Figure K2. LADM code lists for external classes

Annex L. Interface Classes (informative)

There may be interface classes added to LADM to support the generation and management of products and services. These interface classes are considered to be user-defined, and outside the scope of LADM. However, to illustrate the concept of interface class, three interface classes are shown, for parties (see Figure L1), spatial units (see Figure L2), and maps with spatial units – e.g. cadastral maps (see Figure L3).

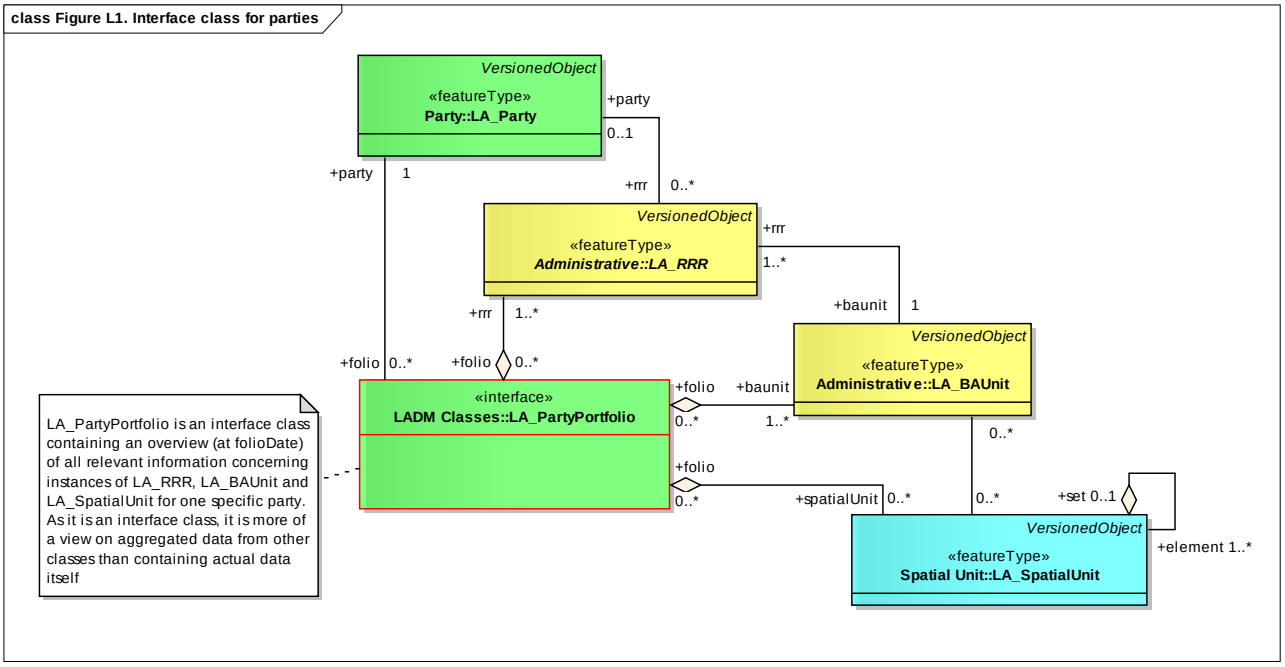


Figure L1. Interface class for parties

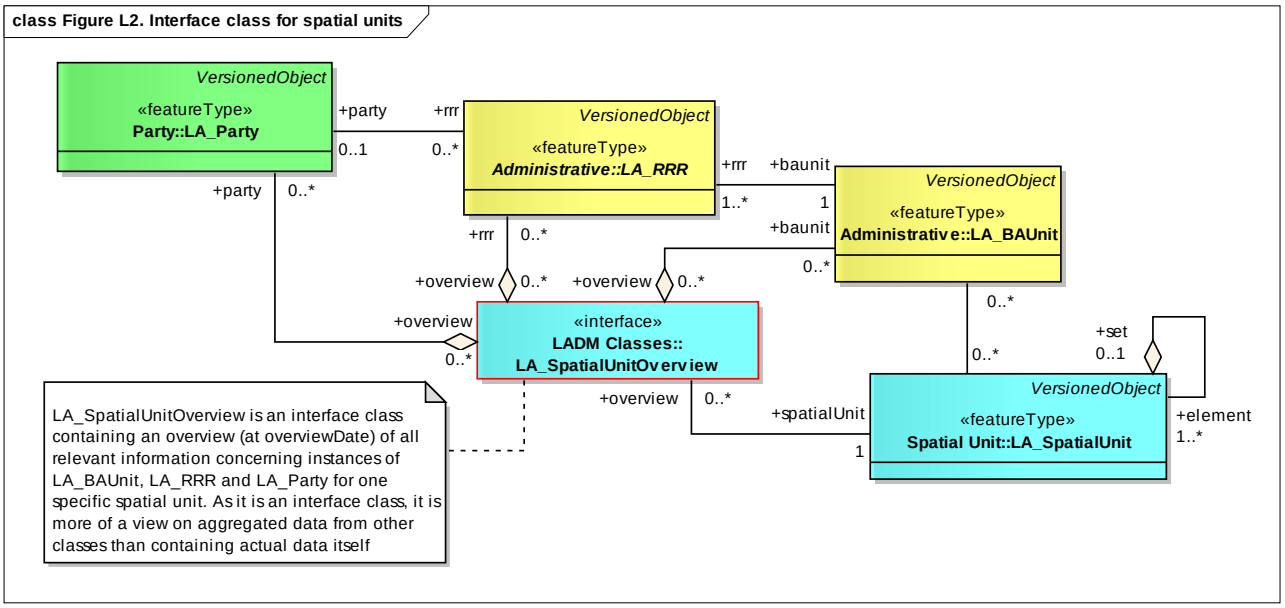


Figure L2. Interface class for spatial units

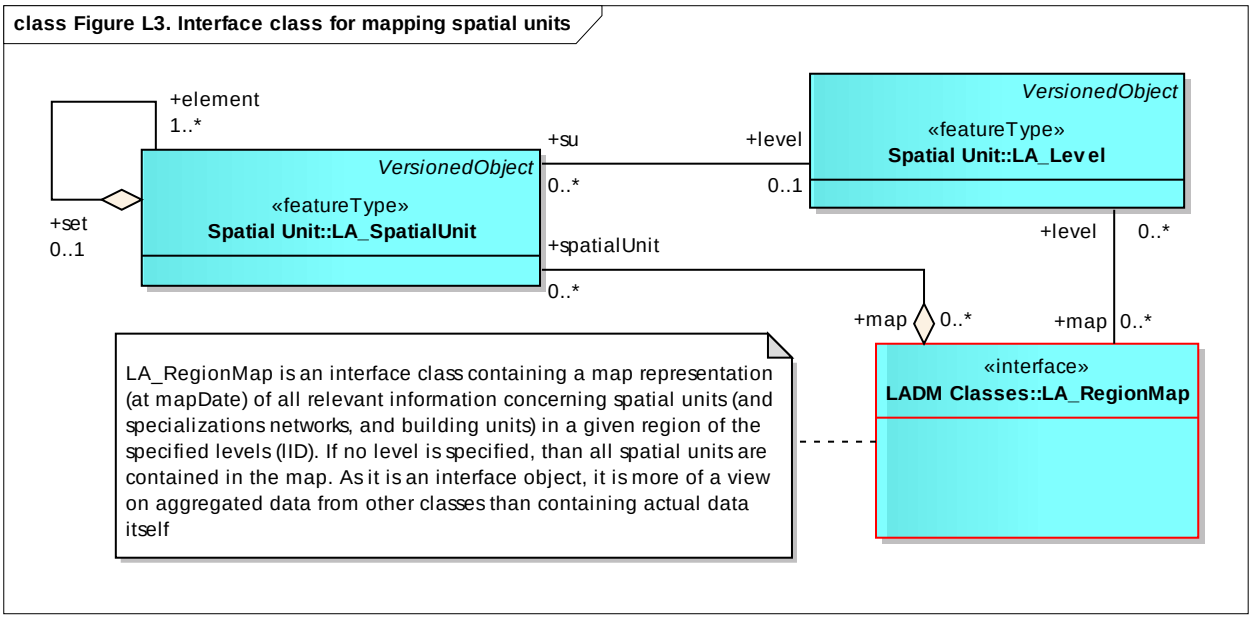


Figure L3. Interface class for mapping spatial units

Annex M. Modelling Land Administration Processes (informative)

Besides the data modelling aspect of the dynamic processes, LADM provides support for investigating how functions and processes are related to each other. The UML class diagrams should therefore further be completed by end users with state diagrams (use case, sequence, collaboration, state or activity diagrams), covering other aspects. Activity diagrams show how processes are related to the information (data), and how it ‘flows’ from one into the other. In all the other types of UML diagrams, actors or organizations play an important role, and this can be dependent on (national) arrangements. The introduction of different ‘stages’ of spatial unit (point, image, surveyed), right (start, landhold, freehold), and party further reflect the dynamic nature of the system.

Annex N. History and Dynamic Aspects (informative)

Two different views are used to model the result of dynamic systems (discrete changes in the state of the system):

(1) Event based modelling. In event based modelling, transactions are modelled as separate entities within the system (with their own identity and set of attributes). The event is represented by an instance of LA_Source. When the start state is known, and all events are known, it is possible to reconstruct every state in the past, by reversing the whole chain of events. It is also possible to represent the current state, and not to keep the start state (and go back in time via the ‘reversal’ of events). In order to have full suport for event based modelling the related process models should be described (which is outside the scope of this International Standard)

(2) State based modelling. In state based modelling, the states (that is to say, the results) are modelled explicitly: every object is assigned (at least) two dates/times which indicate the time interval during which the object is recorded in the system as actual version. Through the comparison of two successive states it is possible to reconstruct what happened as a result of one specific event. It is straightforward to obtain the state at a given moment in time, by selecting the object based on a time interval (tmin-tmax). The temporal aspect is inherited from class VersionedObject with its attributes beginLifespanVersion and endLifespanVersion. The class LA_RRR has an additional temporal attribute called timeSpec, which is capable of handling other temporal representations, such as a recurring pattern (every week-end, every summer, etc.). Note that most objects inherit the temporal attributes via either LA_Party, LA_RRR, LA_BAUnit or LA_SpatialUnit – or directly via VersionedObject.

LADM covers both event based modelling (via class LA_Source), and state based modelling (via class VersionedObject). In addition to event based and state based modelling, it is also possible for explicit parent-child associations between the spatial units to be modelled (lineage), for example, when a spatial unit is subdivided. However, as these associations can also be derived from a spatio-temporal overlay, LADM has not been made more complex through explicit parent-child relationships.

Annex O. Feature Catalogue LADM (normative)

O1. Special Classes

VersionedObject (abstract)

Subclass of:

Definition: this class is introduced in LADM to manage and maintain historical data in the database

Attribute: beginLifespanVersion

Value type: DateTime

Definition: start time of a specific instance version

Multiplicity: 1

Attribute: endLifespanVersion

Value type: DateTime

Definition: end time of a specific instance version

Multiplicity: 0..1

Attribute: quality

Value type: DQ_Element

Definition: quality of a specific instance version

Multiplicity: 0..*

Attribute: source

Value type: CI_ResponsibleParty

Definition: responsible organization of a specific instance version

Multiplicity: 0..*

LA_Source (abstract)

Subclass of:

Definition: an instance of a subclass of class LA_Source is a administartive source or a spatial source

Attribute: acceptance

Value type: DateTime

Definition: the date of force of law of the source by an authority

Multiplicity: 0..1

Attribute: extArchiveID

Value type: ExtArchive

Definition: the identifier of a source in an external registration

Multiplicity: 0..1

Attribute: lifeSpanStamp

Value type: DateTime

Definition: the moment that the event represented by the instance of LA_Source is further processed in the LA system; i.e. the moment of endLifeSpanVersion of old instances and beginLifeSpanVersion of new instances

Multiplicity: 0..1

Attribute: maintype

Value type: CI_PresentationFormCode

Definition: the type of document

Multiplicity: 0..1

Attribute: recordation

Value type: DateTime

Definition: the date of registration (recordation) of the source by registering authority

Multiplicity: 0..1

Attribute: sID

Value type: Oid

Definition: the identifier of the source

Multiplicity: 1

Attribute: submission

Value type: DateTime

Definition: the date of submission of the source by a party

Multiplicity: 0..1

O2. Package Party

Class	Package
LA_Party	Party

LA_GroupParty	Party
LA_PartyMember	Party

LA_Party

Subclass of: VersionedObject

Definition: person, or group of persons, or juridical person that compose an identifiable single (legal) entity, or a basic administrative unit

Attribute: name

Value type: CharacterString

Definition: the name of the party

Multiplicity: 0..1

Attribute: extPID

Value type: Oid

Definition: the identifier of the party in an external registration

Multiplicity: 0..1

Attribute: role

Value type: LA_PartyRoleType

Definition: the role of a party in the data update and maintenance process

Multiplicity: 0..*

Attribute: type

Value type: LA_PartyType

Definition: the type of the party

Multiplicity: 1

Attribute: pID

Value type: Oid

Definition: the identifier of the party

Multiplicity: 1

LA_GroupParty

Subclass of: LA_Party, VersionedObject

Definition: any number of parties, forming together a distinct entity, with each party registered

Attribute: groupID

Value type: Oid

Definition: the identifier of a group party

Multiplicity: 1

Attribute: type

Value type: LA_GroupPartyType

Definition: the type of the group party

Multiplicity: 1

LA_PartyMember

Subclass of: VersionedObject

Definition: a party registered and identified as a constituent of a group party

Attribute: share

Value type: Rational

Definition: the fraction of the whole

Multiplicity: 0..1

O3. Package Administrative

Class	Package
LA_BAUnit	Administrative
LA_RRR	Administrative
LA_Right	Administrative
LA_Restriction	Administrative
LA_Responsibility	Administrative
LA_Mortgage	Administrative
LA_AdministrativeSource	Administrative

LA_BAUnit

Subclass of:	VersionedObject
Definition:	administrative entity consisting of zero or more spatial units against which (one or more) unique and homogeneous rights (e.g. ownership right or land use right), responsibilities and restrictions are associated to the whole entity, as included in a Land Administration system

Attribute: name

Value type:	CharacterString
Definition:	the name of the basic administrative unit
Multiplicity:	0..1

Attribute: uID

Value type:	Oid
Definition:	the identifier of the basic administrative unit
Multiplicity:	1

Attribute: type

Value type:	LA_BAUnitType
Definition:	the type of the basic administrative unit
Multiplicity:	1

LA_RRR (abstract)

Subclass of:	VersionedObject
Definition:	an instance of a subclass of LA_RRR is a right , a restriction, or a responsibility

Attribute: description

Value type:	CharacterString
Definition:	description regarding the right, restriction or responsibility
Multiplicity:	0..1

Attribute: share

Value type:	Rational
Definition:	a share in an instance of a subclass of LA_RRR
Multiplicity:	0..1

Attribute: shareCheck

Value type: Boolean

Definition: boolean indicating whether the constraint is applicable

Multiplicity: 0..1

Attribute: timeSpec

Value type: ISO14825AnnD_Type

Definition: operational use of a right in time sharing

Multiplicity: 0..1

LA_Right

Subclass of: LA_RRR

Definition: formal or informal entitlement to own, to do something

Attribute: type

Value type: LA_RightType

Definition: the type of the right

Multiplicity: 1

LA_Restriction

Subclass of: LA_RRR

Definition: formal or informal entitlement to refrain from doing something

Attribute: type

Value type: LA_RestrictionType

Definition: the type of the restriction

Multiplicity: 1

Attribute: partyRequired

Value type: Boolean

Definition: indicates whether a party is required for the registration of the restriction in the association to LA_Party

Multiplicity: 0..1

LA_Responsibility

Subclass of:	LA_RRR
Definition:	formal or informal obligation to do something

Attribute: type

Value type:	LA_ResponsibilityType
Definition:	the type of the responsibility
Multiplicity:	1

LA_Mortgage

Subclass of:	VersionedObject, LA_Restriction
Definition:	the conveyance of a property by a debtor to a creditor as a security for a financial loan with the condition that the property is returned when the loan is paid off

Attribute: amount

Value type:	Currency
Definition:	the amount of money of the mortgage
Multiplicity:	0..1

Attribute: interestRate

Value type:	Float
Definition:	interest rate of the mortgage (percentage)
Multiplicity:	0..1

Attribute: ranking

Value type:	Integer
Definition:	the ranking order if more than one mortgage applies to a right
Multiplicity:	1

Attribute: type

Value type:	LA_MortgageType
Definition:	the type of the mortgage
Multiplicity:	0..1

LA_AdministrativeSource

Subclass of:	LA_Source
Definition:	source with the administrative description (where applicable) of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected

Attribute: text

Value type:	MultiMediaType
Definition:	the content of the document
Multiplicity:	0..1

Attribute: type

Value type:	LA_AdministrativeSourceType
Definition:	the type of document
Multiplicity:	1

Attribute: availibilityStatus

Value type:	LA_AvailabilityStatusType
Definition:	whether an administrative source is available
Multiplicity:	1

Attribute: purchasePrice

Value type:	Currency
Definition:	the purchase price in relation to a transaction
Multiplicity:	0..1

O4. Package Spatial Unit

Class	Package
LA_SpatialUnit	Spatial Unit
LA_SpatialUnitGroup	Spatial Unit
LA_LegalSpaceBuildingUnit	Spatial Unit
LA_LegalSpaceNetwork	Spatial Unit
LA_Level	Spatial Unit
LA_RequiredRelationshipSpatialUnit	Spatial Unit

LA_SpatialUnit

Subclass of:	VersionedObject
Definition:	a single area (or multiple areas) of land or water, or a single volume (or multiple volumes) of space

Attribute: extAddressID

Value type:	Oid
Definition:	the link to external address(es) of the spatial unit
Multiplicity:	0..*

Attribute: area

Value type:	LA_AreaValue
Definition:	the area value
Multiplicity:	0..*

Attribute: dimension

Value type:	LA_DimensionType
Definition:	the dimension of the spatial unit
Multiplicity:	0..1

Attribute: label

Value type:	CharacterString
Definition:	short textual description of the spatial unit
Multiplicity:	0..1

Attribute: referencePoint

Value type:	GM_Point
Definition:	the coordinates of a point inside the spatial unit
Multiplicity:	0..1

Attribute: suID

Value type:	Oid
Definition:	the spatial unit identifier
Multiplicity:	1

Attribute: volume

Value type: LA_VolumeValue

Definition: the volume value (in case of bounded 3D description)

Multiplicity: 0..*

LA_SpatialUnitGroup

Subclass of: VersionedObject

Definition: any number of spatial units, considered as an entity

Attribute: label

Value type: CharacterString

Definition: short textual description of the spatial unit group

Multiplicity: 0..1

Attribute: hierachyLevel

Value type: Integer

Definition: the level in the hierarchy of the (administrative or zoning) subdivision

Multiplicity: 1

Attribute: name

Value type: CharacterString

Definition: the name of the spatial unit group

Multiplicity: 0..1

Attribute: referencePoint

Value type: GM_Point

Definition: the coordinates of a point within the spatial unit group

Multiplicity: 0..1

Attribute: sugID

Value type: Oid

Definition: the identifier of the spatial unit group

Multiplicity: 1

LA_LegalSpaceBuildingUnit

Subclass of:	LA_SpatialUnit
Definition:	component of building (the legal, recorded or informal space of the physical entity)

Attribute: type

Value type:	LA_BuildingUnitType
Definition:	the type of the building unit
Multiplicity:	0..1

Attribute: buildingUnitID

Value type:	Oid
Definition:	the identifier of the building unit
Multiplicity:	0..1

LA_LegalSpaceNetwork

Subclass of:	LA_SpatialUnit
Definition:	the description of the legal, recorded or informal space of a utility network

Attribute: belowSurface

Value type:	LA_NetworkLevelType
Definition:	an underground network, or an above-the-ground network, or mixed
Multiplicity:	0..1

Attribute: extPhysicalNetworkID

Value type:	Oid
Definition:	a reference to the physical (technical) description of the network in an external information source
Multiplicity:	0..1

Attribute: status

Value type:	LA_NetworkStatusType
Definition:	the status of the network
Multiplicity:	0..1

Attribute: type

Value type: LA_NetworkType

Definition: the type of the network

Multiplicity: 0..1

LA_Level

Subclass of: VersionedObject

Definition: collection of spatial units with a geometric and/or thematic coherence

Attribute: lID

Value type: Oid

Definition: the identifier of the level

Multiplicity: 1

Attribute: name

Value type: CharacterString

Definition: the name of the level

Multiplicity: 0..1

Attribute: registerType

Value type: LA_RegisterType

Definition: the register type of the content of the level

Multiplicity: 1

Attribute: structure

Value type: LA_StructureType

Definition: the structure of the level geometry

Multiplicity: 0..1

Attribute: type

Value type: LA_LevelContentType

Definition: the type of the content of the level

Multiplicity: 0..1

LA_RequiredRelationshipSpatialUnit

Subclass of:	VersionedObject
Definition:	explicit association between spatial units

Attribute: relationship

Value type:	ISO19125_Type
Definition:	an ISO 19125-2 spatial type
Multiplicity:	0..1

O5. Subpackage Surveying

Class	Package
LA_Point	Surveying
LA_SpatialSource	Surveying

LA_Point

Subclass of:	VersionedObject
Definition:	point derived from a spatial source which may be used to define one or more boundary faces or boundary face strings

Attribute: interpolationRole

Value type:	LA_InterpolationType
Definition:	the role of point in the structure of a straight line or curve
Multiplicity:	1

Attribute: originalLocation

Value type:	GM_Point
Definition:	the calculated co-ordinates, based on observations
Multiplicity:	1

Attribute: pID

Value type:	Oid
Definition:	the point identifier
Multiplicity:	1

Attribute: monumentation

Value type:	LA_MonumentationType
Definition:	the type of monumentation
Multiplicity:	0..1

Attribute: productionMethod

Value type:	LI_Lineage
Definition:	lineage
Multiplicity:	0..1

Attribute: spaceDimension

Value type:	Integer
Definition:	the number of dimensions
Multiplicity:	1

Attribute: transAndResult

Value type:	LA _Transformation
Definition:	transformation and transformed location
Multiplicity:	0..*

Attribute: pointType

Value type:	LA_PointType
Definition:	the type of point
Multiplicity:	1

Attribute: estimatedAccuracy

Value type:	Length
Definition:	the estimated accuracy of the point
Multiplicity:	1

LA_SpatialSource

Subclass of:	LA_Source
Definition:	source with the spatial description of a (part of) one or more spatial units

Attribute: measurements	
Value type:	OM_Observation
Definition:	the observations, and measurements, as a basis for mapping, and as a basis for historical reconstruction of the location of (parts of) the spatial unit in the field
Multiplicity:	0..*
Attribute: procedure	
Value type:	SF_SurveyProcedure
Definition:	the way of surveying
Multiplicity:	0..1
Attribute: type	
Value type:	LA_SpatialSourceType
Definition:	the type of the spatial source
Multiplicity:	1

O6. Subpackage Spatial Representation

Class	Package
LA_BoundaryFaceString	Spatial Representation
LA_BoundaryFace	Spatial Representation

LA_BoundaryFaceString	
Subclass of:	VersionedObject
Definition:	boundary forming part of the outside of a spatial unit
Attribute: bfsID	
Value type:	Oid
Definition:	the boundary face string identifier
Multiplicity:	0..1
Attribute: geometry	
Value type:	GM_MultiCurve
Definition:	boundary represented via a curve at ground level
Multiplicity:	0..1

Attribute: locationByText

Value type: CharacterString

Definition: the boundary represented in text

Multiplicity: 0..1

LA_BoundaryFace

Subclass of: VersionedObject

Definition: 2-dimensional (2D) topological primitive

Attribute: bfID

Value type: Oid

Definition: the boundary face identifier

Multiplicity: 1

Attribute: geometry

Value type: GM_Surface

Definition: the boundary represented via a surface in 3D

Multiplicity: 1

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