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

Introduction

This International Standard 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 (geospatial) components thereof. LADM provides a reference model which will serve two goals:

— to provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on a Model Driven Architecture (MDA), and

— 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:

— it should cover the common aspects of land administration all over the world;

— it should be based on the conceptual framework of ‘Cadastre 2014’ of the International Federation of Surveyors (FIG) (KAUFMANN and STEUDLER, 1998; see Bibliography, and www.fig.net/cadastre2014/);

— it should be as simple as possible in order to be useful in practice;

— the geospatial aspects follow the ISO/TC 211 conceptual model.

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 I, 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 a deeds registration system, another a title registration system. 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:

— keeping the contents of these relationships up-to-date (based on regulations and related transactions); and

— 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, geospatial data bases, modelling standards, open systems, and GIS), as well with a growing demand for new services, a market pull (e-governance, sustainable development, electronic conveyance, and the 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.

Geographic information — Land Administration Domain Model

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 four 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 utility networks);

4) spatial sources (surveying), and 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 utility network data, archive data, and taxation data. However, LADM provides 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, *Currency names and code elements*

ISO 8601:2004, *Information interchange — Representation of dates and times*

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

ISO 14825:2004, *Intelligent transport systems — Geographic Data Files (GDF) — Overall data specification*

ISO/TS 19103:2005, *Geographic Information — Conceptual schema language*

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

ISO 19106:2004, *Geographic Information — Profiles*

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

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

ISO 19111:2007, *Geographic 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 19132:2007, *Geographic information — Location-based services — Reference model*

ISO 19153:—[1)] , *Geospatial Digital Rights Management Reference Model*

ISO 19156:—[2)] , *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 **parties** 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.

1) Under development.

2) Under development.

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. For a restriction zero parties are possible.

NOTE 2 An basic administrative unit may play the role of party.

NOTE 3. A baunit should get an unique identifier when registered, or recorded.

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
set that represents the limit of an entity [ISO 19107:2003]

4.1.4
boundary face
face that is used in the 3-dimensional representation of a **boundary** of a **spatial unit**

EXAMPLE Boundary faces are used when the implied vertical and unbounded faces of a boundary face string are not sufficient to describe 3D spatial units. Boundary faces close volumes in height (e.g. every apartment floor), or in depth (e.g. an underground parking garage), or in all other directions to form a bounded volume. The volumes represent legal space (in contrast with physical space).

4.1.5
boundary face string
boundary forming part of the outside of a **spatial unit**

NOTE Boundary face strings are used to represent the boundaries of spatial units via linestrings in 2D. 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).

4.1.6
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.

4.1.7
face
2-dimensional topological primitive [ISO 19107:2003]

4.1.8
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).

4.1.9
land
the surface of the Earth, the materials beneath, the air above and all things fixed to the soil [UN/ECE, 2004]

NOTE In LADM, land also includes water.

4.1.10
land administration
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.

4.1.11
level
set of **spatial units**, with a geometric, and/or topologic, 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.

4.1.12
liminal spatial unit
spatial unit on the threshold between 2D and 3D representations

4.1.13
party
a person or organisation that plays a role in a **rights** transaction [ISO/CD 19153]

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.).

4.1.14
party member
party registered and identified as a constituent of a **group party**

4.1.15
point
0-dimensional geometric primitive, representing a position [ISO 19107:2003]

NOTE 1 A point may be used to define one or more boundary faces or boundary face strings.

NOTE 2 Points can be observed by e.g. terrestrial surveying, but also by photo interpretation, image interpretation, or identification on an existing map.

4.1.16
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

[ISO 19106:2004, definition 4.5]

4.1.17
required relationship
explicit association between either **spatial units,** or between **basic administrative units**

NOTE 1 Due to inaccurate geometries, or missing geometries, geospatial overlay techniques may generate invalid, or no relationships between spatial units, which can be introduced by required relationships.

NOTE 2 Relationships for spatial units may be defined with ISO 19125-2 types.

4.1.18
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.

4.1.19
restriction
formal or informal entitlement to refrain from doing something

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

4.1.20
right
action, activity or class of actions that a system participant may perform on or using an associated resource [ISO 19132:2007]

NOTE 1 A right may provide a formal or informal entitlement to own or do something.

NOTE 2 This International Standard deals with real rights and personal rights. Real rights are rights over or in respect of spatial units (e.g. ownership, or usufruct). Personal rights are rights that parties have (e.g. fishing rights, grazing rights, or using rights).

NOTE 3 Rights may be overlapping, or may be in disagreement.

EXAMPLE Ownership right, apartment right, tenancy right, possessions, customary right, Islamic right (e.g. miri or milk), indigenous right, or informal right.

4.1.21
source
document providing facts

NOTE Any kind of document may be added as a source according to ISO 19115:2003, B.3.2.

4.1.22
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).

4.1.23
spatial unit
single area (or multiple areas) of land and/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 This standard supports either 2-dimensional (2D), 3-dimensional (3D), or mixed (2D and 3D) representations of spatial units, which may be described in text (“from this tree to that river”), or based on a single point, or represented as a set of unstructured lines, or as a surface, or as a 3D volume.

NOTE 4 Independent 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.

4.1.24
spatial unit group
any number of **spatial units**, considered as an entity

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

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.

4.1.25
utility network
network describing the topology of a utility

NOTE 1 A utility network may be attributed with information about its legal, recorded or informal space.

NOTE 2 A utility 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 utility network.

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 Packages and subpackages of LADM

LADM, as a product, is a conceptual schema. LADM is organized into three packages, and one subpackage. A (sub)package is a group of classes, with a certain degree of cohesion. Each (sub)package has its own namespace. (Sub)packages facilitate 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 (sub)packages (with their respective classes) is presented in Figure 1. The three packages are: (1) Party Package (see 5.3), (2) Administrative Package (see 5.4), and (3) Spatial Unit Package (see 5.5). The Surveying and Spatial Representation Subpackage (see 5.6) is a subpackage of the Spatial Unit package.

All figures are UML 2.1 diagrams. To differentiate LADM classes from other classes of ISO 19100 standards, their names are given LA_ as a prefix.

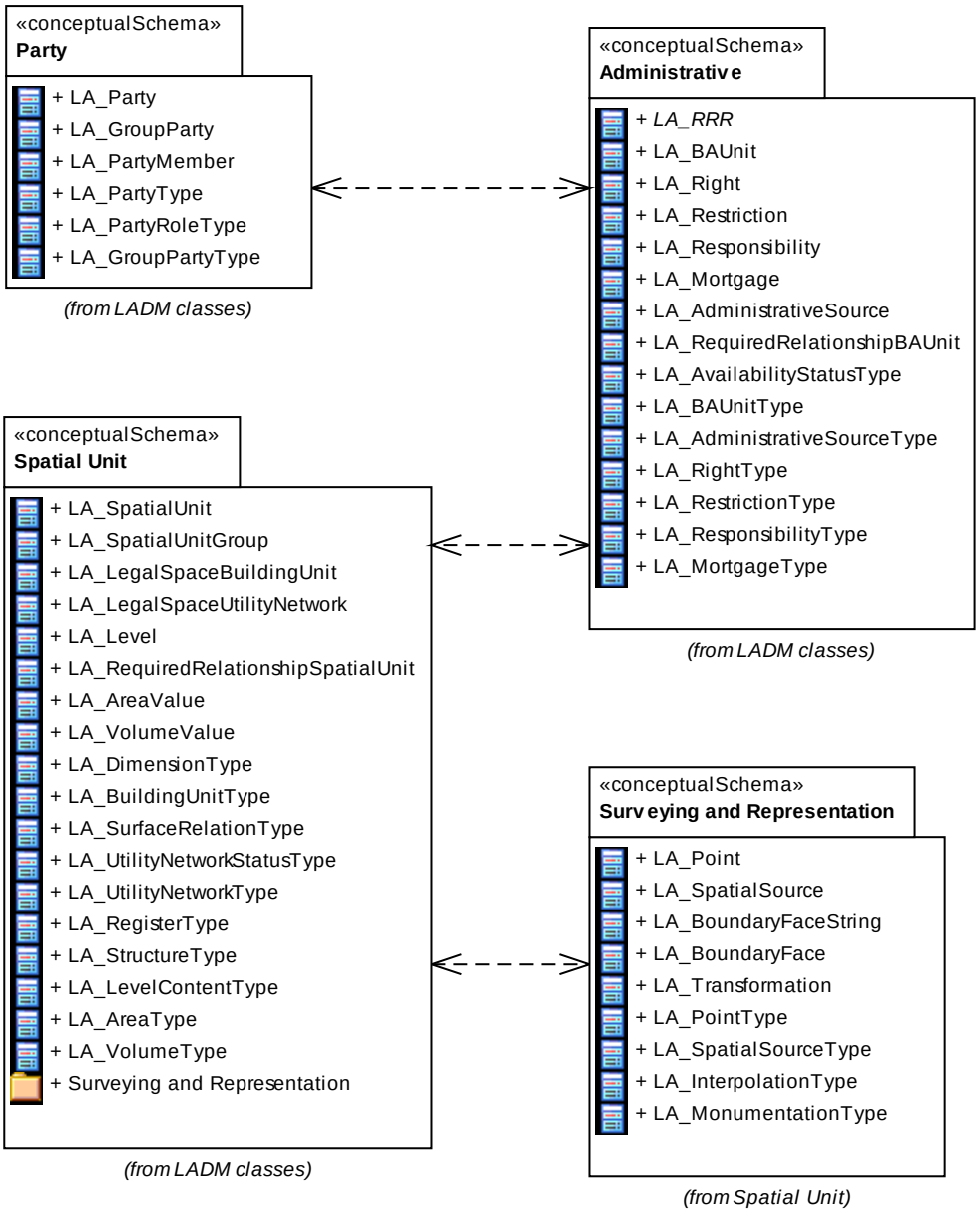


Figure 1 — LADM overview of (sub)packages (with their respective classes)

5.2 Basic classes of LADM

The core LADM is based on four basic classes:

1) Class LA_Party. Instances of this class are *parties* (see 4.1.13).

2) Class LA_RRR. Instances of subclasses of LA_RRR are *rights* (see 4.1.20), *restrictions* (see 4.1.19), or *responsibilities* (see 4.1.18).

3) Class LA_BAUnit. Instances of this class are *basic administrative units* (see 4.1.2).

4) Class LA_SpatialUnit. Instances of this class are *spatial units* (see 4.1.23).

Figure 2 shows the basic classes of LADM. The details of these four basic classes, and all other LADM classes, are presented in Clause 6.

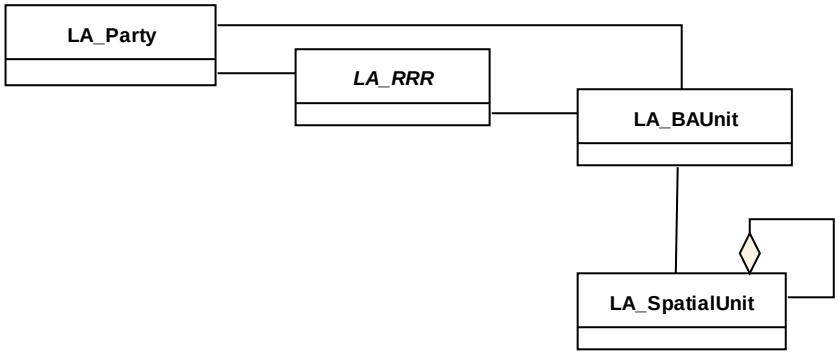


Figure 2 — Basic classes of LADM

5.3 Party Package

The main class of the Party Package is the basic class LA_Party (with party as an instance; see 4.1.13). LA_Party has a specialization: LA_GroupParty (with group party as an instance; see 4.1.8). Between LA_Party and LA_GroupParty there is an optional association class: LA_PartyMember (with party member as an instance; see 4.1.14). See Figure 3.

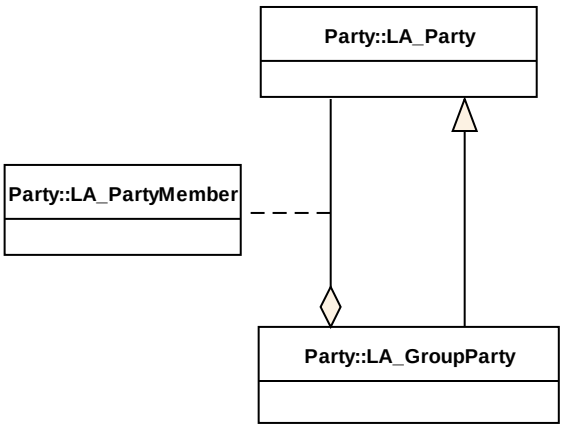


Figure 3 — Classes of Party Package

A group party, being a specialization of party, is also a party. This 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 the Administrative Package are basic classes LA_RRR and LA_BAUnit. See Figure 4.

LA_RRR has three classes as specializations:

1) LA_Right, with rights as instances (see 4.1.20). Rights are primarily in the domain of private or customary law. Ownership rights are generally based on (national) legislation, and code lists in LADM are in support of this, see Annex J.

2) LA_Restriction, with restrictions as instances (see 4.1.19). 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). A *mortgage*, an instance of class LA_Mortgage, is a special restriction of 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.

3) LA_Responsibility, with responsibilities as instances (see 4.1.18).

Instances of class LA_BAUnit are *basic administrative units* (abbreviated as *baunits*), see 4.1.2. Baunits are needed, among other things, to register ‘basic property units’, which consist of several spatial units, belonging to a party, under the same right (a right must be 'homogeneous' over the whole baunit). There must be a unique right for each baunit in order to establish a unique combination between an instance of LA_Party, an instance of a subclass of LA_RRR, and an instance of LA_BAUnit.

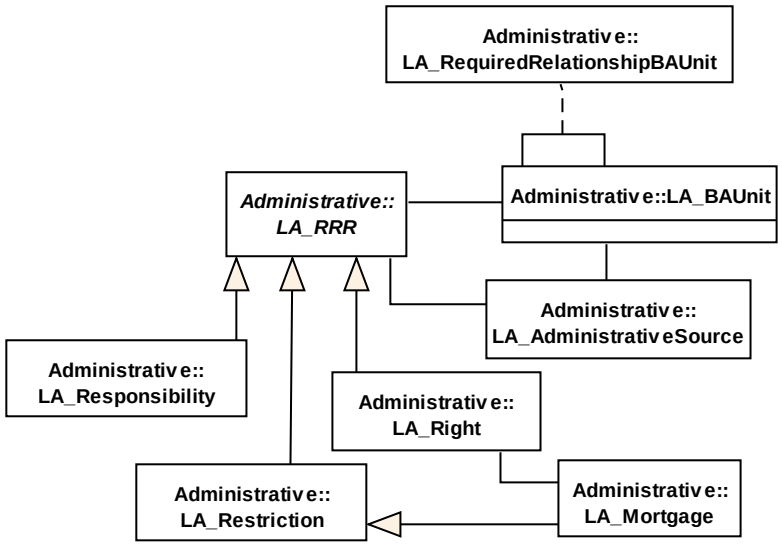


Figure 4 — Classes of Administrative Package

In principle, all rights, restrictions and responsibilities are based on an administrative source (see 4.1.1), as instances from class LA_AdministrativeSource.

Class LA_RequiredRelationshipBAUnit allows creating instances of relationships between baunits. It allows maintaining explicit spatial relationships in the absence of spatial units to describe the baunits, or in the presence of inaccurate geometry of spatial units to generate reliable implicit spatial relationships.

5.5 Spatial Unit Package

The main class of the Spatial Unit Package is basic class LA_SpatialUnit, with spatial units (see 4.1.23) as instances. *LA_Parcel is an alias for LA_SpatialUnit*, see Figure 5.

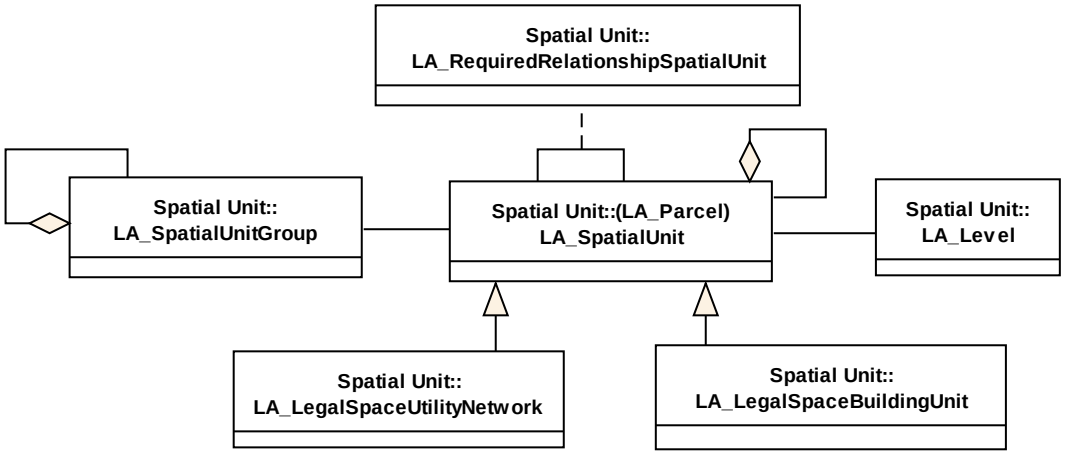


Figure 5 — Classes of Spatial Unit Package

Spatial units may be grouped into two forms:

1) as *spatial unit groups* (see 4.1.24), as instances of class LA_SpatialUnitGroup, and realized by an aggregation relationship of LA_SpatialUnitGroup onto itself, see Figure 5. An example of a spatial unit group is a municipality. A spatial unit group may be a grouping of other spatial unit groups. In implementations of LADM, this is to enable the inclusion of spatial unit identifiers in hierarchical zones.

2) as sub spatial units, or *subparcels*, that is a grouping of a spatial unit into its parts. This is realized by an aggregation relationship of LA_SpatialUnit onto itself, see Figure 5. Parts, in their turn, may be grouped into subparts (*subsubparcels*), and so on.

Spatial units are refined into two specializations:

1) *building units* (see 4.1.6), as instances of class LA_LegalSpaceBuildingUnit. A building unit concerns *legal space*, which does not necessarily coincide with the physical space of a building.

2) *utility networks* (see 4.1.25), as instances of class LA_LegalSpaceUtilityNetwork. A utility network concerns *legal space*, which does not necessarily coincide with the physical space of a utility network.

An instance of LA_Level is a *level* (see 4.1.11).

Required relationships (see 4.1.17) are explicit links between spatial units, and instances of class LA_RequiredRelationshipSpatialUnit. 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 geospatial overlaying techniques (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 override implicit relationships, established through geospatial overlaying techniques.

5.6 Surveying and Representation Subpackage

The four classes of the Surveying and Representation Subpackage are (1) LA_Point, (2) LA_SpatialSource, (3) LA_BoundaryFaceString, and (4) LA_BoundaryFace, see Figure 6.

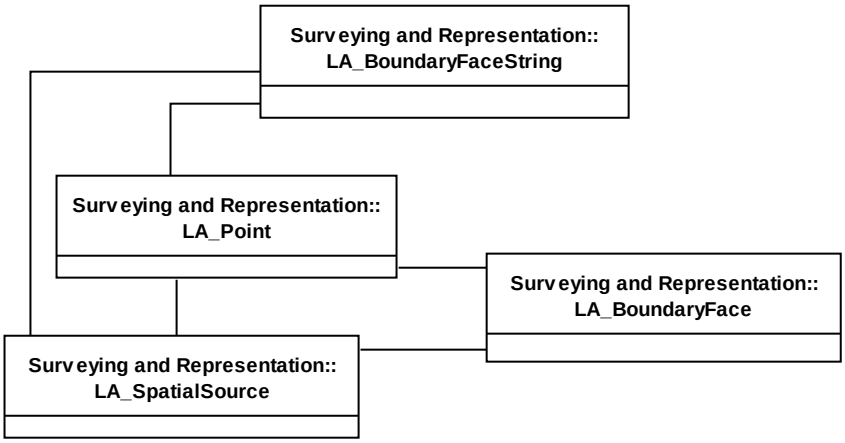


Figure 6 — Classes of Surveying and Representation Subpackage

Points (see 4.1.15), as instances of LA_Point, can be acquired in the field (with classical surveys, or with satellite navigation systems), in an office, or compiled from various sources, for example using forms, field sketches, ortho-images, or orthophotos. The acquisition of points (a survey) may concern the identification of spatial units on a photograph, on an image, or on a topographic map; cycloramas or pictometry methods (multiple images from different angles) may also be used for that purpose.

A survey is documented with *spatial sources* (see 4.1.22), instances from class LA_SpatialSource. This may be the final (sometimes formal) documents, 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. a registered survey plan, or an aerial photograph). Paper based documents (which may be scanned) can 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_Spatial-Source. 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 with multiple reference systems, are all supported in LADM.

2D and 3D representations of spatial units use *boundary face strings* (see 4.1.5) as instances of class LA_BoundaryFaceString, and *boundary faces* (see 4.1.4) as instances of class LA_BoundaryFace.

Coordinates themselves either come from *points*, or are captured as linear geometry. Spatial units may share the same representation structure: existing 2D data, whether topologically structured or not, or polygons, or unstructured boundaries, or simply point or textual descriptions, can be included, for more details see Annex E.

LADM supports the increasing use of 3D representations of spatial units, without putting an additional burden on the existing 2D representations. Another feature of the spatial representation within LADM is that there is no mismatch between spatial units that are represented in 2D and spatial units that are represented in 3D, for more details see Annex B. Furthermore, LADM is based on accepted and available spatial schemata, such as published in ISO 19107:2003.

6 Content of classes of LADM and their associations

6.1 Introduction

All LADM classes adhere to ISO/TS 19103 stereotype class f*eatureType*. Many LADM classes are subclasses of class *VersionedObject* (see 6.2.1).

LADM presupposes 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. See Annex K.

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 are not used. Therefore, *country profiles* can be used for customizing LADM, to meet specific needs. See Annex D.

6.2 Special classes

6.2.1 VersionedObject

Class VersionedObject is introduced in LADM to manage and maintain historical data in the database. History 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 historical moment. For more on history and dynamic aspects of LA systems, see Annex N.

Classes LA_Party, LA_GroupParty, LA_PartyMember, LA_Mortgage, LA_RRR, LA_BAUnit, LA_SpatialUnit, LA_SpatialUnitGroup, LA_RequiredRelationshipSpatialUnit, LA_RequiredRelationshipBAUnit, LA_Level, LA_BoundaryFaceString, LA_BoundaryFace, and LA_Point are all subclasses of class VersionedObject, see Figure 7.

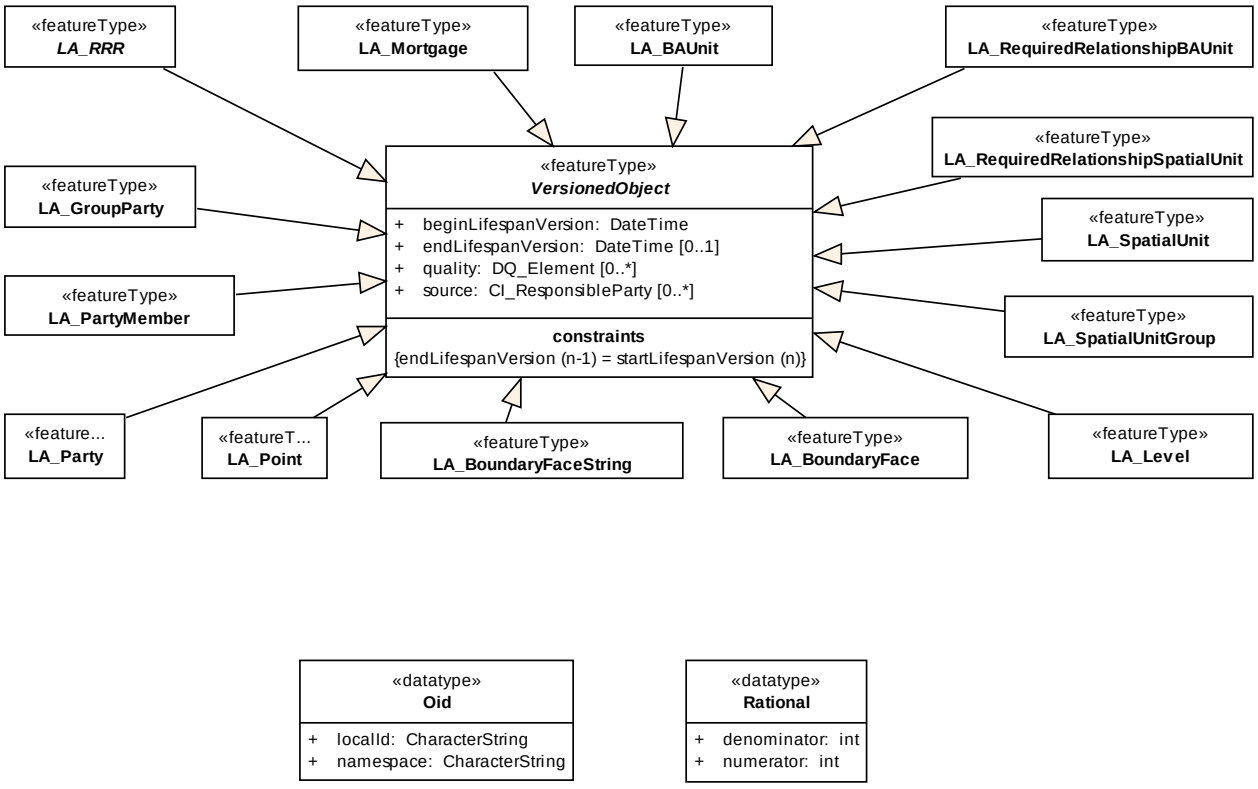


Figure 7 — Classes VersionedObject (with subclasses), Rational, and Oid

The attributes of VersionedObject are:

— beginLifespanVersion: Start time of a specific instance version;
Value type: DateTime (type from ISO/TS 19103)
Multiplicity: 1

— endLifespanVersion: End time of a specific instance version;

Value type: DateTime (type from ISO/TS 19103)
Multiplicity: 0..1

— quality: Quality of a specific instance version;
Value type: DQ_Element (type from ISO 19113)
Multiplicity: 0..*

— source: Responsible organization of a specific instance version;
Value type: CI_ResponsibleParty (type from ISO 19115)
Multiplicity: 0..*.

6.2.2 LA_Source

In LADM, administrative sources and spatial sources are modelled, starting with an abstract class LA_Source. LA_Source has two subclasses: (1) LA_AdministrativeSource (see 6.4.7), and (2) LA_SpatialSource (see 6.6.2), see Figure 8.

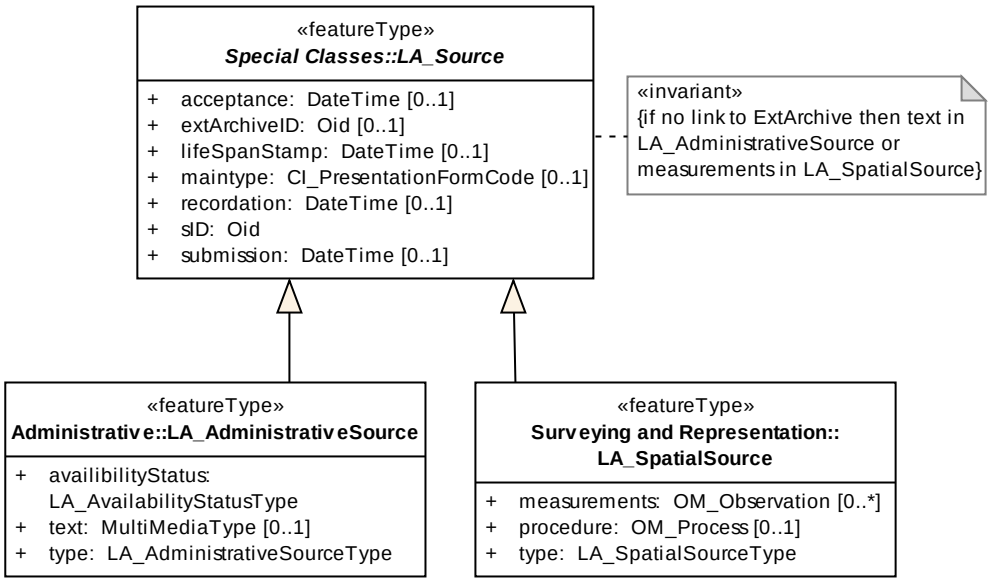


Figure 8 — Class LA_Source (with subclasses)

The attributes of LA_Source are:

— acceptance: The date of force of law of the source by an authority;
Value type: DateTime
Multiplicity: 0..1

— extArchiveID: The identifier of a source in an external registration;
Value type: ExtArchive
Multiplicity: 0..1

— lifeSpanStamp: The moment that the event, represented by the instance of LA_Source, is further processed in the LA system (this is the moment of endLifespanVersion of old instances, and the moment of beginLifespanVersion of new instances);
Value type: DateTime
Multiplicity: 0..1

— maintype: The type of document;
Value type: CI_PresentationFormCode
Multiplicity: 0..1

— recordation: The date of registration (recordation) of the source by the registering authority;

Value type: DateTime
Multiplicity: 0..1

— sID: The identifier of the source;
Value type: Oid
Multiplicity: 1

— submission: The date of submission of the source by a party;
Value type: DateTime
Multiplicity: 0..1.

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 10).

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

Generic data type Rational 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 a fraction;
Value type: int
Multiplicity: 1

— numerator: The top number in the notation of a fraction;
Value type: int
Multiplicity: 1.

6.2.4 Oid

Generic data type Oid 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;
Value type: CharacterString
Multiplicity: 1

— namespace: Identifier for the data source of the spatial object;
Value type: CharacterString
Multiplicity: 1.

NOTE 1 The local identifier should be unique within the namespace, i.e. no other spatial object should carry the same identifier.

NOTE 2 If INSPIRE compliance is needed, then he 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.

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 basic administrative unit can

be a party (e.g. a basic administrative unit holding an easement on another basic administrative unit), see Figure 9.

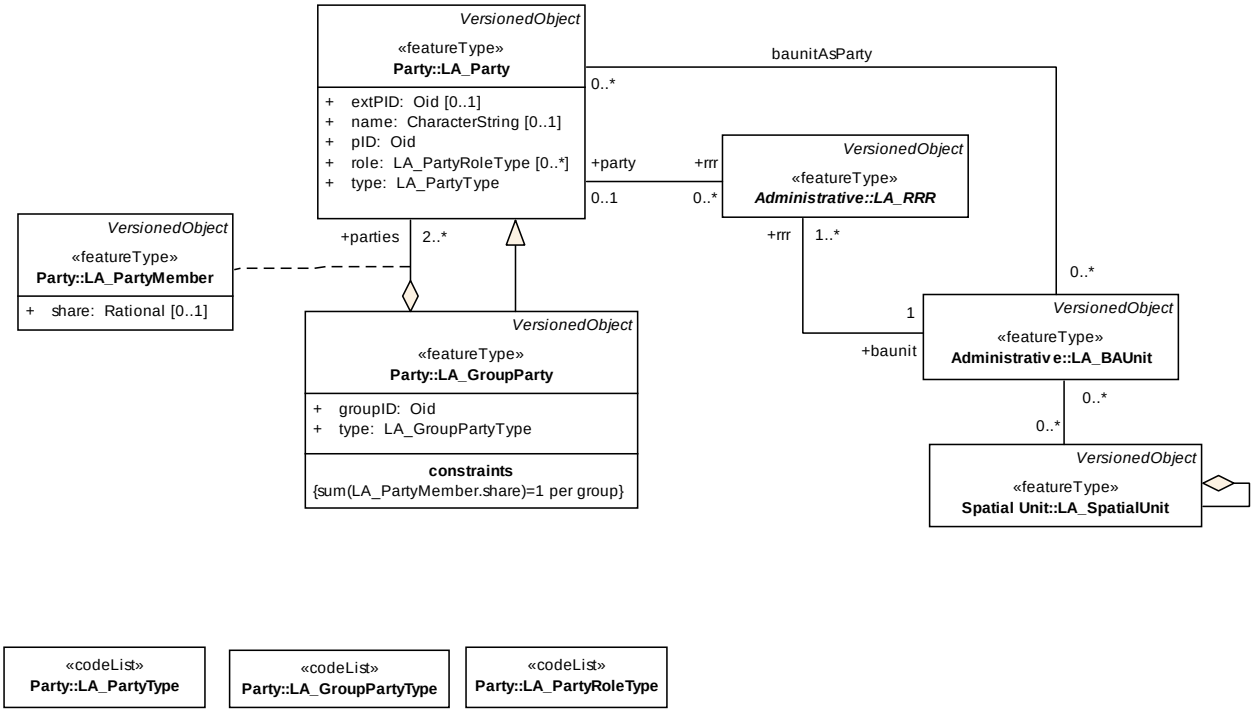


Figure 9 — Content of Party Package and associations to other basic classes

The attributes of LA_Party are:

— extPID: The identifier of the party in an external registration;
  Value type: Oid
  Multiplicity: 0..1

— name: The name of the party;
  Value type: CharacterString
  Multiplicity: 0..1

— pID: The identifier of the party;
  Value type: Oid
  Multiplicity: 1

— role: The role of the party in the data update and maintenance process;
  Value type: LA_PartyRoleType
  Multiplicity: 0..*

— type: The type of the party;
  Value type: LA_PartyType
  Multiplicity: 1.

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

EXAMPLE Parties are demonstrated in instance diagrams, see Figures C.3, C.4, C.13 and C.31 (Annex C).

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 9.

The attributes of LA_GroupParty are:

— groupID: The identifier of a group party;
  Value type: Oid
  Multiplicity: 1

— type: The type of a group party;
  Value type: LA_GroupPartyType
  Multiplicity: 1.

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

EXAMPLE Group parties are demonstrated in instance diagrams, see Figures C.3, C.4, C.5 and C.26 (Annex C).

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 9.

The attribute of LA_PartyMember is:

— share: The fraction of the whole;
  Value type: Rational
  Multiplicity: 0..1.

6.3.4 Code lists for Party Package

Party Package has three code lists (LA_PartyRoleType, LA_GroupPartyType, and LA_PartyType); see Figure 9. 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 10.

The attributes of LA_BAUnit are:

— name: The name of the basic administrative unit;
  Value type: CharacterString
  Multiplicity: 0..1

— type: The type of the basic administrative unit;
  Value type: LA_BAUnitType
  Multiplicity: 1

— uID: The identifier of the basic administrative unit;

Value type: Oid
Multiplicity: 1.

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 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 register spatial units from different levels as one unit. If (parts of) spatial units are included, or eliminated from the baunit, the uID stays the same, with a different version. In this approach, a mortgage can only be established on the complete baunit, not on one or more of the registered spatial units.

NOTE 5 A (group of) baunits may be a party.

EXAMPLE Basic administrative units (baunit's) are demonstrated in instance diagrams, see Figures C.1, C.17, C.24, C.25, C.26, C.28, C.30, C.31, C.33, C.34 and C.35 (Annex C).

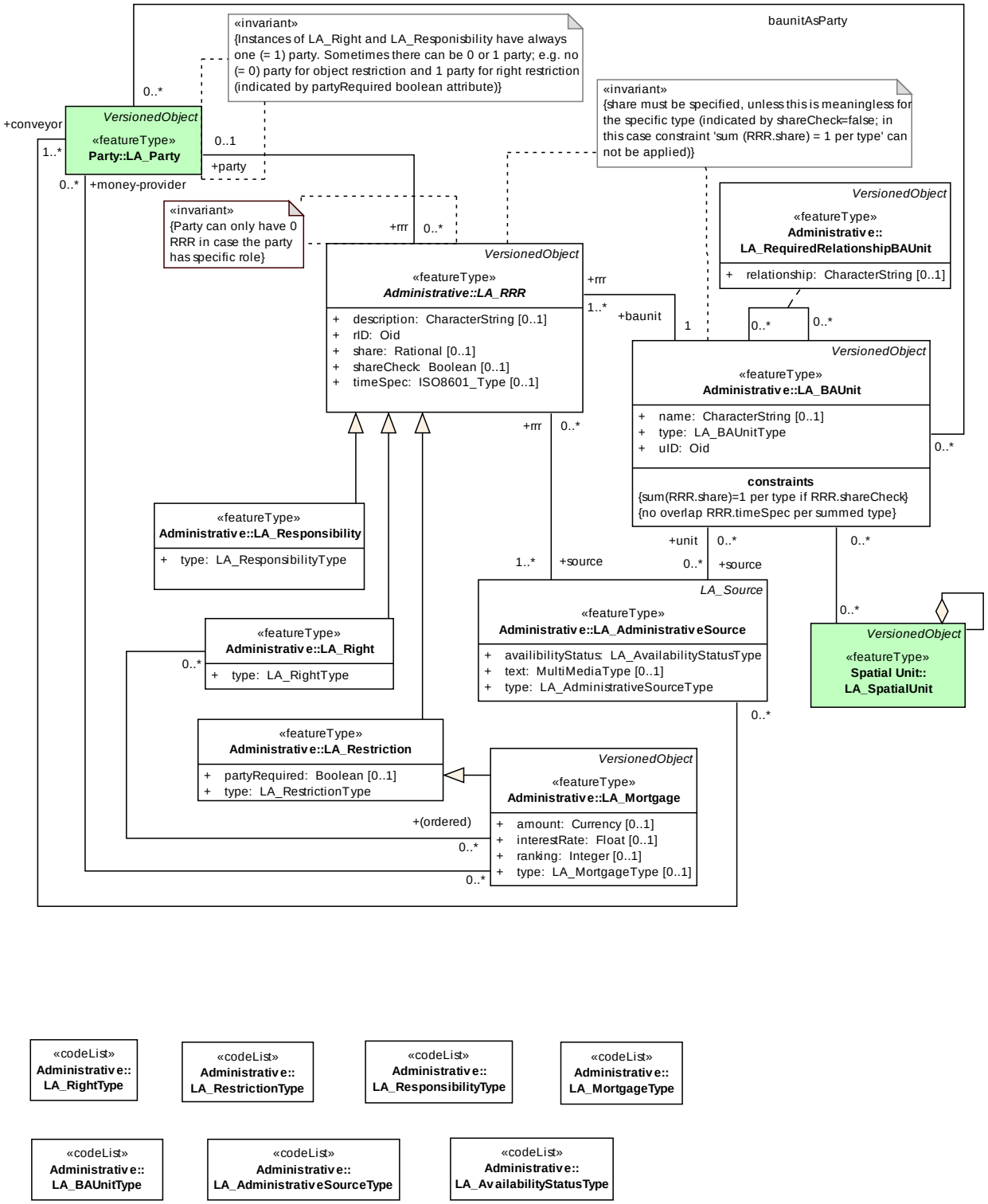


Figure 10 — Content of Administrative Package with associations to other basic classes

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 10.

The attributes of LA_RRR are:

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

— rID: The RRR identifier;
  Value type: Oid
  Multiplicity: 1

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

— shareCheck: Indicates whether the constraint in class LA_BAUnit is applicable;
  Value type: Boolean
  Multiplicity: 0..1

— timeSpec: Operational use of a right in time sharing;
  Value type: ISO 8601 type
  Multiplicity: 0..1.

NOTE 1 There is a constraint in class LA_BAUnit, that the sum of all shares is equal to 1, e.g. two parties, each holding a share of ½ in a right of ownership; or one party holding ¼ and another holding ¾ (see also NOTE 2 in 6.4.1 for a further explanation of the constraint).

NOTE 2 Attribute timeSpec 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 14825:2004, Annex D; ISO 14825:2004, Annex D may be used instead of ISO 8601:2004).

NOTE 3 There is a constraint that no overlap is allowed between timeSpecs for the same RRR type and the same basic administrative unit.

6.4.3 LA_Right

An instance of class LA_Right is a *right* (see 4.1.20). LA_Right is a subclass of class LA_RRR, see Figure 10.

The attribute of LA_Right is:

— type: The type of the right;
  Value type: LA_RightType
  Multiplicity: 1.

EXAMPLE Rights are demonstrated in instance diagrams, see Figures C.1, C.8, C.11, C.30 and C.31 (Annex C).

6.4.4 LA_Restriction

An instance of class LA_Restriction is a restriction. LA_Restriction is a subclass of class LA_RRR, Figure 10.

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;
  Value type: Boolean
  Multiplicity: 0..1

— type: The type of the restriction;
  Value type: LA_RestrictionType

Multiplicity: 1.

NOTE Attribute partyRequired is set to TRUE (by default), if for the registration of the restriction a party is required, and to FALSE, if the restriction is considered as an spatial unit restriction. The spatial unit restriction is always via a baunit.

EXAMPLE Restrictions are demonstrated in instance diagrams, see Figures C.9, C.16, C.19, C.21, C.22 and C.23 (Annex C).

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 10.

The attribute of LA_Responsibility is:

— type: The type of the responsibility;
Value type: LA_ResponsibilityType
Multiplicity: 1.

EXAMPLE Responsibilities are demonstrated in instance diagrams, see Figure C.20 (Annex C).

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), to class LA_AdministrativeSource, and to class LA_Party (the party that is the money provider), see Figure 10.

The attributes of LA_Mortgage are:

— amount: The amount of money of the mortgage;
Value type: Currency
Multiplicity: 0..1

— interestRate: Interest rate of the mortgage (percentage);
Value type: Float
Multiplicity: 0..1

— ranking: The ranking order, if more than one mortgage applies to a right (or rights);
Value type: Integer
Multiplicity: 0..1

— type: The type of the mortgage;
Value type: LA_MortgageType
Multiplicity: 0..1.

NOTE ISO 4217 should be used for the list of currencies in the ISO/TS 19103 measure.

EXAMPLE Mortgages are demonstrated in instance diagrams, see Figures C.10, C.11 and C.15 (Annex C).

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 Figures 8 and 10.

The attributes of LA_AdministrativeSource are:

— availabilityStatus: Availability status of an administrative source;
Value type: LA_AvailabilityStatusType
Multiplicity: 1

— text: The content of the document;

Value type: MultiMediaType
Multiplicity: 0..1

— type: The type of document;
Value type: LA_AdministrativeSourceType
Multiplicity: 1.

NOTE 1 An availability status for an administrative source is required, because it may be lost, e.g. by a disaster.

NOTE 2 ISO/IEC 13240 Interchange Standard for Multimedia Interactive Documents (ISMID) may be used for the content of the document.

6.4.8 LA_RequiredRelationshipBAUnit

An instance of association class LA_RequiredRelationshipBAUnit is a *required relationship* between basic administrative units, see Figure 10.

The attribute of LA_RequiredRelationship is:

— relationship: The description of the required relationship;
Value type: CharacterString
Multiplicity: 0..1.

NOTE 1 Instances of LA_RequiredRelationshipBAUnit override implicit relationships, established through geospatial overlaying techniques.

NOTE 2 Even if the geometry of spatial units is accurate, there may be legal reasons to establish required relationships between baunits.

NOTE 3 LA_RequiredRelationshipBAUnit is a versioned object class. Different life cycle attributes than the versioned object ones, can be added using the attribute ‘relationship’.

6.4.9 Code lists for Administrative Package

Administrative Package has code lists for classes LA_AdministrativeSourceType, LA_MortgageType, LA_RightType, LA_RestrictionType, LA_ResponsibilityType, LA_AvailabilityStatusType, 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 11.

The attributes of LA_SpatialUnit are:

— area: The area of the 2D spatial unit;
Value type: LA_AreaValue
Multiplicity: 0..*

— dimension: The dimension of the spatial unit;
Value type: LA_DimensionType
Multiplicity: 0..1

— extAddressID: The link to external address(es) of the spatial unit;
Value type: Oid
Multiplicity: 0..*

— label: Short textual description of the spatial unit;
Value type: CharacterString

Multiplicity: 0..1

— referencePoint: The coordinates of a point inside the spatial unit;
Value type: GM_Point
Multiplicity: 0..1

— suID: The spatial unit identifier;
Value type: Oid
Multiplicity: 1

— surfaceRelation: Indicates whether a spatial unit is above or below the surface;
Value type: LA_LevelType
Multiplicity: 0..1

— volume: The volume of the 3D spatial unit;
Value type: LA_VolumeValue
Multiplicity: 0..*.

NOTE The method 'CreateArea' returns a geometric primitive GM_MultiSurface, which includes a geometric primitive GM_Surface.

EXAMPLE Spatial units are demonstrated in instance diagrams, see Figure C.6, C.7, C.16, C.17, C.22, C.29 and C.33 (Annex C).

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 11.

The attributes of LA_SpatialUnitGroup are:

— hierarchyLevel: The level in the hierarchy of an administrative, or zoning subdivision;
Value type: Integer
Multiplicity: 1

— label: Short textual description of the spatial unit group;
Value type: CharacterString
Multiplicity: 0..1

— name: The name of the spatial unit group;
Value type: CharacterString
Multiplicity: 0..1

— referencePoint: The coordinates of a point within the spatial unit group;
Value type: GM_Point
Multiplicity: 0..1

— sugID: The identifier of the spatial unit group;
Value type: Oid
Multiplicity: 1.

NOTE The highest level in the hierarchy of a subdivision (*country*) is 1; lower levels are incremented by 1.

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 11.

The attributes of LA_LegalSpaceBuildingUnit are:

— buildingUnitID: The identifier of the building unit;
Value type: Oid
Multiplicity: 0..1

— type: The type of the building unit;
Value type: LA_BuildingUnitType
Multiplicity: 0..1.

EXAMPLE Building units are demonstrated in instance diagrams, see Figures C.6, C.23, C.25, C.28, C.29, C.34 and C.35 (Annex C).

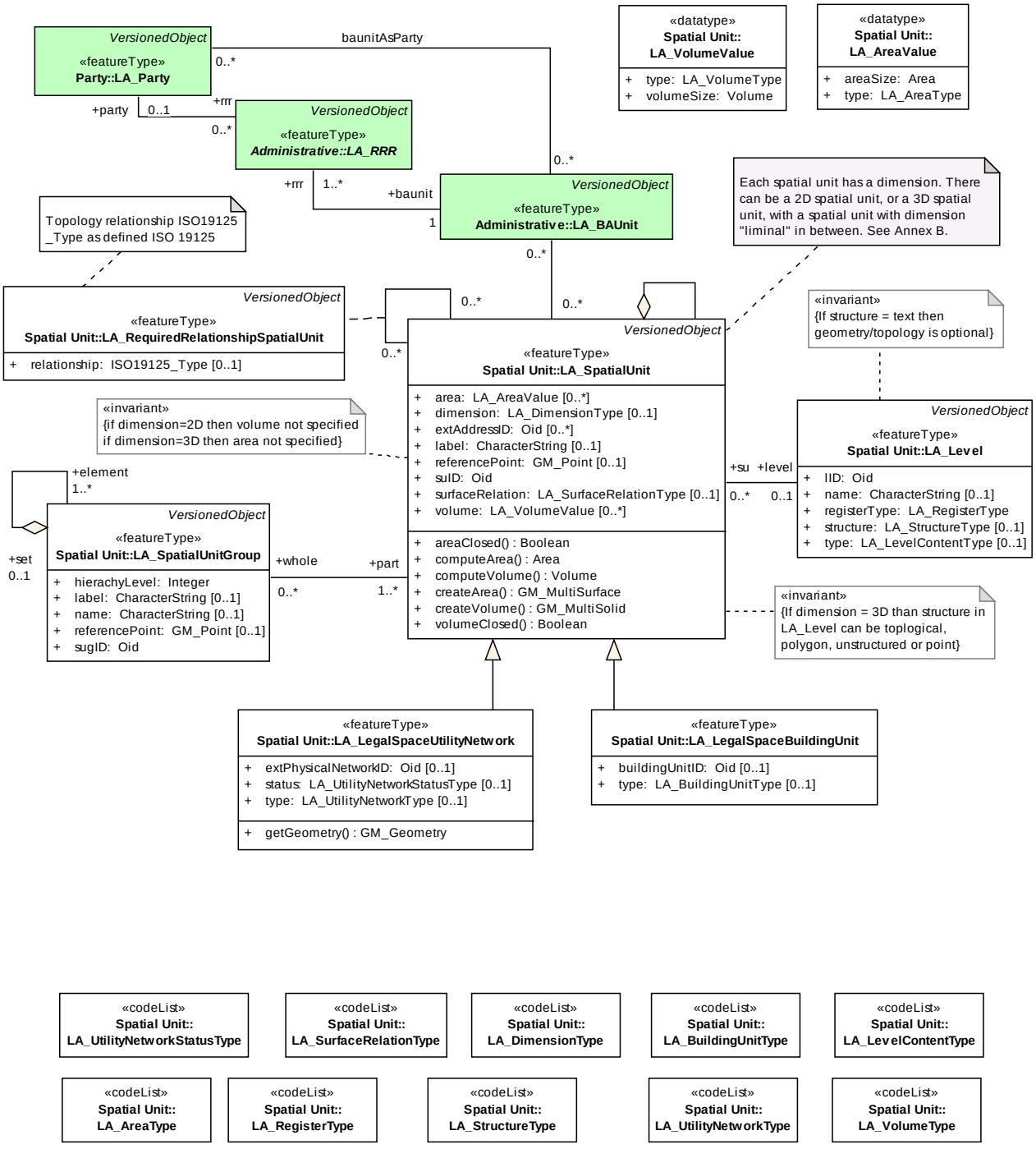


Figure 11 — Content of Spatial Unit Package with associations to other basic classes

6.5.4 LA_LegalSpaceUtilityNetwork

An instance of LA_LegalSpaceUtilityNetwork is a utility network. LA_LegalSpaceUtilityNetwork is a subclass of class LA_SpatialUnit, see Figure 11.

The attributes of LA_LegalSpaceUtilityNetwork are:

— extPhysicalUtilityNetworkID: A reference to the physical (technical) description of the utility network;
Value type: Oid
Multiplicity: 0..1

— status: The status of the utility network;
Value type: LA_UtilityNetworkStatusType
Multiplicity: 0..1

— type: The type of the utility network;
Value type: LA_UtilityNetworkType
Multiplicity: 0..1.

EXAMPLE Utility networks are demonstrated in instance diagrams, see Figure C.15 (Annex C).

6.5.5 LA_Level

An instance of class LA_Level is a level. LA_Level is associated to class LA_SpatialUnit, see Figure 11.

The attributes of LA_Level are:

— IID: The identifier of the level;
Value type: Oid
Multiplicity: 1

— name: The name of the level;
Value type: CharacterString
Multiplicity: 0..1

— registerType: The register type of the content of the level;
Value type: LA_RegisterType
Multiplicity: 1

— structure: The structure of the level geometry;
Value type: LA_StructureType
Multiplicity: 0..1

— type: The type of the content of the level;
Value type: LA_LevelContentType
Multiplicity: 0..1.

EXAMPLE Levels are demonstrated in instance diagrams, see Figure C.2, C.14, C.16, C.21, C23, C.24, C.25 and C.32 (Annex C).

6.5.6 LA_RequiredRelationshipSpatialUnit

An instance of association class LA_RequiredRelationshipSpatialUnit is a *required relationship* between spatial units, see Figure 11.

The attribute of LA_RequiredRelationshipSpatialUnit is:

— relationship: The description of the required relationship;
Value type: ISO 19125-2 spatial type
Multiplicity: 0..1.

6.5.7 Data types and code lists and for Spatial Unit Package

Spatial Unit Package has two data types (LA_AreaVolume and LA_VolumeValue), and ten code lists (LA_BuildingUnitType, LA_AreaType, LA_VolumeType, LA_UtilityNetworkLevelType, LA_DimensionType, LA_UtilityNetworkStatusType, LA_RegisterType, LA_UtilityNetworkType, LA_LevelContentType, and LA_StructureType), see Figure 11. For examples of values, see Annex J.

6.6 Classes of Surveying and Representation Subpackage

6.6.1 LA_Point

An instance of class LA_Point is a point, see Figure 12.

The attributes of LA_Point are:

— estimatedAccuracy: The estimated accuracy of the point;
Value type: Length
Multiplicity: 1

— interpolationRole: The role of point in the structure of a straight line or curve;
Value type: LA_InterpolationType
Multiplicity: 1

— monumentation: The type of monumentation;
Value type: LA_MonumentationType
Multiplicity: 0..1

— originalLocation: The calculated co-ordinates, based on measurements and observations;
Value type: GM_Point
Multiplicity: 1

— pID: The point identifier;
Value type: Oid
Multiplicity: 1

— pointType: The type of point;
Value type: LA_PointType
Multiplicity: 1

— productionMethod: Lineage;
Value type: LI_Lineage
Multiplicity: 0..1

— transAndResult: Transformation and transformed location;
Value type: LA _Transformation
Multiplicity: 0..*.

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 8 and Figure 12.

The attributes of LA_SpatialSource are:

— measurements: The observations and measurements;
Value type: OM_Observation
Multiplicity: 0..*

— procedure: The way of surveying;
Value type: OM_Process
Multiplicity: 0..1

— type: The type of the spatial source;
Value type: LA_SpatialSourceType
Multiplicity: 1.

NOTE 1 Measurements are the basis for mapping, and for historical reconstruction of the location of (parts of) the spatial unit in the field.

NOTE 2 The association to LA_BAUnit is derived via intermediate classes.

6.6.3 LA_BoundaryFaceString

An instance of class LA_BoundaryFaceString is a boundary face string. LA_BoundaryFaceString is associated to class LA_Point and class LA_SpatialSource to document the origin of the geometry, see Figure 12.

The attributes of LA_BoundaryFaceString are:

— bfsID: The boundary face string identifier;
Value type: Oid
Multiplicity: 1

— geometry: The boundary represented via a curve at ground level;
Value type: GM_MultiCurve
Multiplicity: 0..1

— locationByText: The boundary represented in text;
Value type: CharacterString
Multiplicity: 0..1.

NOTE The geometry is either derived from associated class LA_Point, or based on captured linear geometry.

EXAMPLE Boundary face strings are demonstrated in instance diagrams, see Figure C.33 (Annex C).

6.6.4 LA_BoundaryFace

An instance of class LA_BoundaryFace is a boundary face. LA_BoundaryFace is associated to class LA_Point and class LA_SpatialSource to document the origin of the geometry, see Figure 12.

The attributes of LA_BoundaryFace are:

— bfID: The boundary face identifier;
Value type: Oid
Multiplicity: 1

— geometry: The boundary represented via a surface in 3D;
Value type: GM_Surface
Multiplicity: 0..1

— locationByText: The boundary represented in text;
Value type: CharacterString
Multiplicity: 0..1.

NOTE The geometry is either derived from associated class LA_Point, or based on captured surface geometry.

EXAMPLE Boundary faces are demonstrated in instance diagrams, see Figure C.7 (Annex C).

6.6.5 Code lists and data types for Surveying Subpackage

Surveying Subpackage has one data type (LA_Transformation) and four code lists (LA_MonumentationType, LA_SpatialSourceType, LA_InterpolationType, and LA_PointType), see Figure 12. For examples of values, see Annex J.

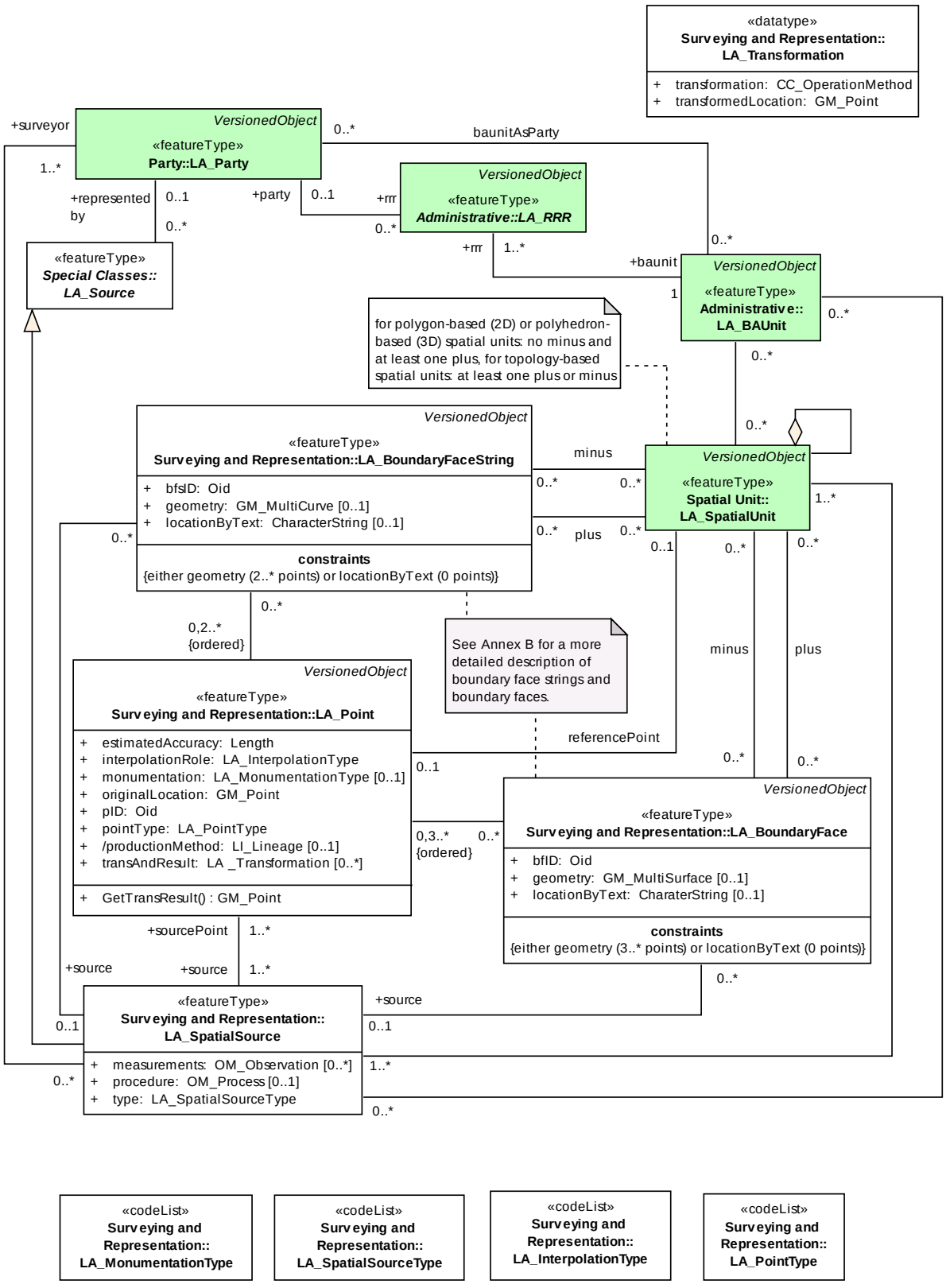


Figure 12 — Content of Surveying and Representation Subpackage with associations to other basic classes

6.7 Associations between classes

In this clause, three tables summarize all relationships between LADM classes: for associations between classes, see Table 6.1; for generalizations between classes, see Table 6.2; and for aggregations between classes, see Table 6.3.

Table 6.1 — Associations between LADM classes

Class 1	*Class 2*	*Role name End 1*	*Multiplicity*	*Role name End 2*	*Multiplicity*
AdministrativeSource	*BAUnit*	*source*	*0..**	*unit*	*0..**
AdministrativeSource	*Party*	*-*	*0..**	*conveyor*	*1..**
AdministrativeSource	*RRR*	*source*	*1..**	*rrr*	*0..**
BAUnit	*BAUnit*	*-*	*0..**	*-*	*0..**
BAUnit	*RRR*	*baunit*	*1*	*rrr*	*1..**
BoundaryFace	*SpatialSource*	*-*	*0..**	*source*	*0..1*
BoundaryFace	*SpatialUnit*	*-*	*0..**	*-*	*0..**
BoundaryFaceString	*Point*	*-*	*0..**	*-*	*0,2..**
BoundaryFaceString	*SpatialSource*	*-*	*0..**	*source*	*0..1*
BoundaryFaceString	*SpatialUnit*	*-*	*0..**	*-*	*0..**
Mortgage	*Right*	*-*	*0..**	*-*	*0..**
Party	*BAUnit*	*-*	*0..1*	*-*	*0..1*
Party	*Mortgage*	*money-provider*	*0..**	*-*	*0..**
Point	*BoundaryFace*	*-*	*0,3..**	*-*	*0..**
Point	*BoundaryFaceString*	*-*	*0,2..**	*-*	*0..**
RRR	*Party*	*rrr*	*0..**	*party*	*0..1*
Source	*Party*	*-*	*0..**	*represented by*	
SpatialSource	*BAUnit*	*-*	*0..**	*-*	*0..**
SpatialSource	*Party*	*-*	*0..**	*surveyor*	*1..**
SpatialSource	*Point*	*source*	*1..**	*sourcePoint*	*1..**
SpatialUnit	*BAUnit*	*-*	*0..**	*-*	*0..**
SpatialUnit	*Level*	*su*	*0..**	*level*	*0..1*
SpatialUnit	*Point*	*-*	*0..1*	*-*	*0..1*
SpatialUnit	*SpatialSource*	*-*	*1..**	*-*	*1..**

Class 1	*Class 2*	*Role name End 1*	*Multiplicity*	*Role name End 2*	*Multiplicity*
SpatialUnit	*SpatialUnit*	*element*	*1..**	*set*	*0..1*
SpatialUnit	*SpatialUnitGroup*	*part*	*1..**	*whole*	*0..**

Table 6.2 — Generalizations between LADM classes

Class 1	*Class 2*
Restriction	Mortgage
RRR	Right
RRR	Restriction
RRR	Responsibility
Party	GroupParty
Source	AdministrativeSource
Source	SpatialSource

Table 6.3 — Aggregations between LADM classes

Class 1	*Class 2*	*Role name End 1*	*Multiplicity*	*Role name End 2*	*Multiplicity*
Party	*GroupParty*	*parties*	*2..**	*group*	*0..**
SpatialUnit	*SpatialUnit*	*element*	*1..**	*set*	*0..1*
SpatialUnitGroup	*SpatialUnitGroup*	*element*	*1..**	*set*	*0..1*

Annex A
(normative)

Abstract Test Suite

A.1 Introduction

The abstract test suite is in conformance with ISO 19105. 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 A.1 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 is documented per class in the clauses below.

NOTE In order to realize this conformance test explicitly and completely, knowledge and understanding of both LADM and the specific country profile is required, because the country profile should not include different structures or solutions, where LADM has standard provisions.

Table A.1 — LADM conformance requirements table

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	
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_LegalSpaceUtilityNetwork	O, 3	
	LA_Level	O, 2	
	LA_RequiredRelationshipSpatialUnit	O, 3	
Surveying and Representation Subpackage		O	
	LA_Point	M, 2	
	LA_SpatialSource	M, 2	
	LA_BoundaryFaceString	M, 2	
	LA_BoundaryFace	O, 3	

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

A.2.1 General

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.2.3 is passed successfully;

— Administrative package: test A.2.2 and test A.2.4 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.2.5 is passed successfully.

A.2.2 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, 4.1.2 and 6.4.1.

d) Test Type: Basic.

A.2.3 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, see 4.1.13 and 6.3.1.

d) Test Type: Basic.

A.2.4 Test case identifier: Administrative::LA_Right

a) 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.

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

c) Reference: level 1 requirement, see 4.1.20, 6.4.2 and 6.4.3.

d) Test Type: Basic.

A.2.5 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 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, see 4.1.23 and 6.5.1.

d) Test Type: Basic.

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

A.3.1 General

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.3.4 and test A.3.5 are passed successfully;

— Administrative package: test A.3.2 and test A.3.7 are passed successfully ;

— Spatial Unit package: test A.3.9 is passed successfully;

  — Spatial Representation subpackage: test A.3.3 is passed successfully

  — Surveying and Representation subpackage: test A.3.6 and test A.3.8 are passed successfully.

A.3.2 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, see 4.1.1, 4.1.22, 6.2.2 and 6.4.7.

d) Test Type: Basic.

A.3.3 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, 4.1.5 and 6.7.1.

d) Test Type: Basic.

A.3.4 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, 4.1.8 and 6.3.2.

d) Test Type: Basic.

A.3.5 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, 4.1.13 and 6.3.3.

d) Test Type: Basic.

A.3.6 Test case identifier: Surveying and Representation::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, see 4.1.15 and 6.6.1

d) Test Type: Basic.

A.3.7 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, see 4.1.19 and 6.4.4.

d) Test Type: Basic.

A.3.8 Test case identifier: Surveying and Representation::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, see 4.1.1, 4.1.22 and 6.2.2.

d) Test Type: Basic.

A.3.9 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, see 4.1.24 and 6.5.2.

d) Test Type: Basic.

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

A.4.1 General

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_LegalSpaceUtilityNetwork, 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.4.5 and test A.4.7 are passed successfully;

— Spatial Unit package: test A.4.3, test A.4.4 and test A.4.6 are passed successfully

    — Spatial Representation subpackage: test A.4.2 is passed successfully

A.4.2 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, 4.1.4 and 6.7.2.

d) Test Type: Basic.

A.4.3 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, 4.1.5 and 6.5.3.

d) Test Type: Basic.

A.4.4 Test case identifier: Spatial Unit::LA_LegalSpaceUtilityNetwork

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

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

c) Reference: level 3 requirement, see 4.1.25 and 6.5.4.

d) Test Type: Basic.

A.4.5 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, 6.4.6.

d) Test Type: Basic.

A.4.6 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, see 4.1.17 and 6.5.6.

d) Test Type: Basic.

A.4.7 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, see 4.1.18 and 6.4.5.

d) Test Type: Basic.

Annex B
(normative)

2D and 3D Representations of Spatial Units

2D and 3D representations of spatial units use *boundary face strings* and *boundary faces* as key concepts (see also Figure 12).

In many countries, a 2D representation is interpreted as a 3D prismatic volume, with no upper and lower bound. Using this interpretation, 2D and 3D representations can be unified:

a) By boundary face strings, for 2D boundaries representations, with a GM_MultiCurve (linestring) for storage. Boundary face strings imply also a series of vertical virtual boundary faces, see Figures B.1 and B.2.

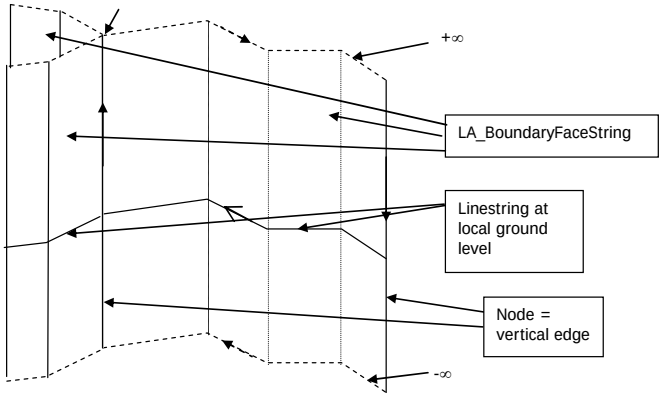


Figure B.1 — Boundary face string concepts

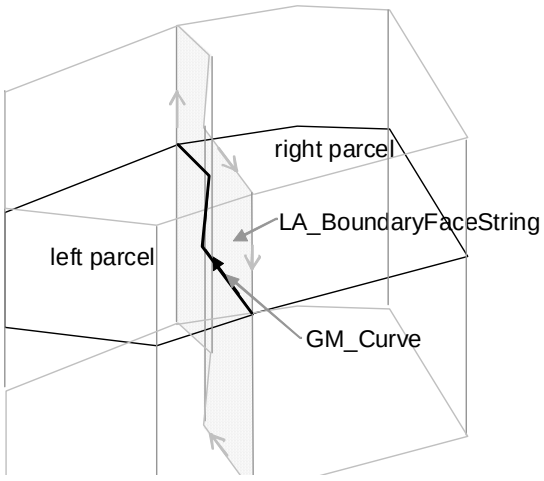


Figure B.2 — Spatial units defined by boundary face strings

b) By boundary faces, for true 3D boundaries representations, with a GM_Surface (that may be curved) for storage. Boundary faces can also have non-vertical true 3D boundaries. This also allows for the representation of a volume, like an inverted cone, where the top is wider than the bottom.

Liminal spatial units are on the threshold of 2D and 3D representations. These representations are a combination of boundary face strings and vertical boundary faces. 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 Figures B.3 and B.4. This method is used for 2D spatial units which are adjacent to 3D spatial units, with a split in the shared vertical boundary faces.

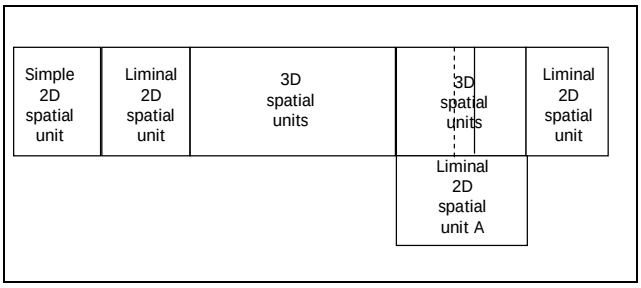


Figure B.3 — Top view of mixed 2D/3D representations

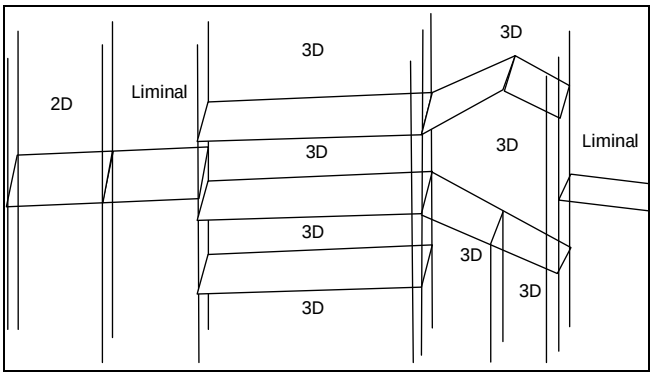


Figure B.4 — Side view showing the mixed use of boundary face strings and boundary faces to define both bounded and unbounded 3D volumes

The attribute ‘dimension’ in class LA_SpatialUnit indicates, whether it concerns a 2D, liminal or 3D representation of a spatial unit.

Annex C
(informative)

Instance Level Cases

The content of this Annex is based on ISO 19109:2005, ISO 19110:2005, ISO 19126:2009 and ISO 19131:2007.

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

1) A leaseholder and an owner. Leasehold and ownership based on civil code for a particular country (Figure C.1).

2) Spatial units with a customary right (Figure C.2).

3) A serving parcel provides access to four parcels, and the serving parcel is not public, but commonly owned by four neighbouring parcels (Figure C.3).

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 (Figure C.4).

5) A group party holds an ownership right on a parcel (Figure C.5).

6) A building contains individual units (apartments), a shared unit, with a common threshold (entrance), and a ground parcel (Figure C.6).

7) A 3D volume spatial unit with one owner (Figure C.7).

8) A timeshare ownership for the month of February (Figure C.8).

9) A restriction not to change a building because of its monumental status (Figure C.9).

10) Mortgage on ownership, bank included as party (Figure C.10).

11) Mortgage on usufruct of ownership, money provider included as party (Figure C.11).

12) Informal right by a party (natural person) on a text spatial unit (Figure C.12).

13) Informal right by a group party on a point spatial unit (Figure C.13).

14) A conflicting claim on a spatial unit (Figure C.14).

15) A utility network with one owner and a mortgage (bank included as party) (Figure C.15).

16) A group party (pastoralists) with an access right for a certain period of time (Figure C.16).

17) A farmer owning a basic property unit (BPU) with several spatial units (example from Finland) (Figure C.17).

18) Value as basis for taxation valid for five years (Figure C.18).

19) A milk right to a spatial unit (Case C.19).

20) A responsibility to clean the ditches (Figure C.20).

21) A right to use a road on a property of somebody else (I) (Figure C.21).

22) A right to use a road on a property of somebody else (II) (Figure C.22).

23) A restriction area (“it is not allowed to built within 200 metres of a fuel station”) with its own geometry (Figure C.23).

24) Spatial unit complex with one owner (Figure C.24).

25) Spatial unit complex with building, one owner (Figure C.25).

26) Complex of parcels with two owners (Figure C.26).

27) Spatial unit with micro credit (Figure C.27).

28) Tax valuations on condominium rights in Spain (Figure C.28).

29) A spatial unit with one owner, with a building from a different owner (Figure C.29).

30) Marriage and inheritance relationships to property (simple) in Spain (Part 1) (Figure C.30).

31) Marriage and inheritance relationships to property (complex) in Spain (Part 2) (Figure C.31).

32) Spanish 'real estate' form of property (Figure C.32).

33) Norwegian categories of basic property units (Part 1) (Figure C.33).

34) Norwegian categories of basic property units (Part 2) (Figure C.34)

35) Individual and joint property rights in Spain (Figure C.35).

36) Grazing rights of pastoralists in Kenya (Figure C.36).

37) Customary rights in Ghana (Figure C.37).

38) An accepted subdivision, resulting in parcel A and parcel B (Figure C.38).

39) Buying and selling of a spatial unit (Figure C.39).

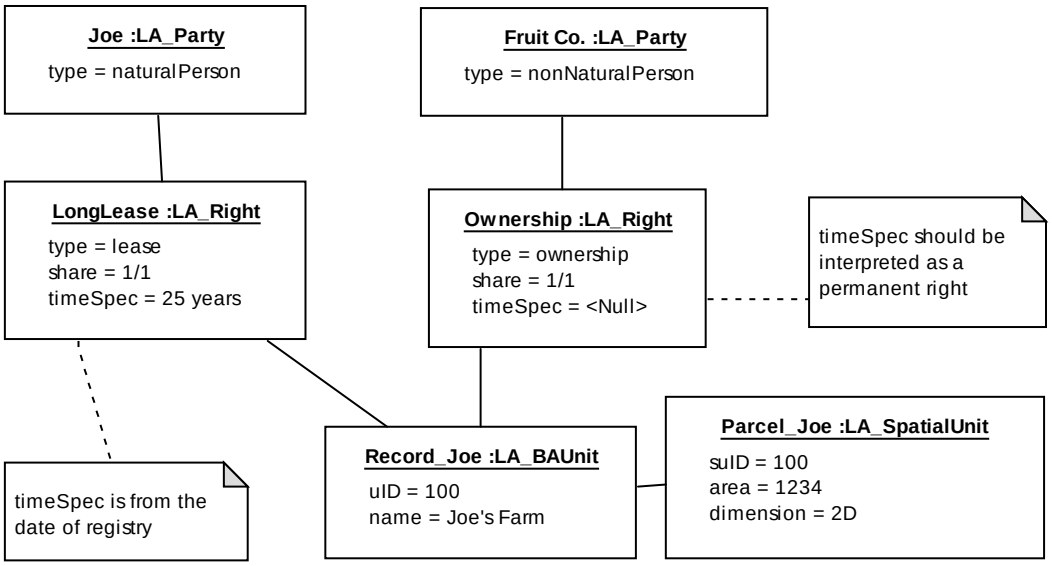


Figure C.1 — A leaseholder (Joe) and an owner (Fruit Co). Leasehold and ownership based on civil code for a particular country

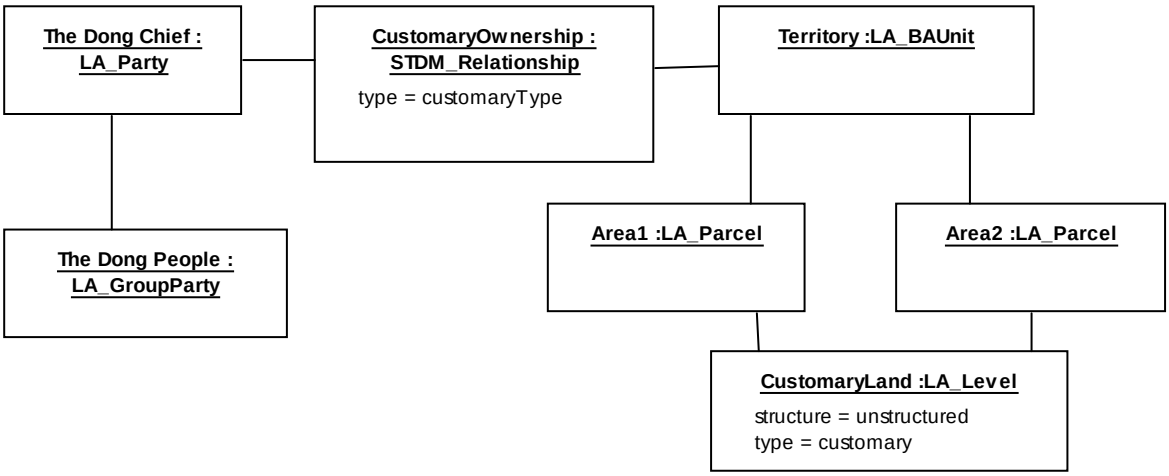


Figure C.2 — Spatial units (Area 1:LA_Parcel, and Area 2:LA_Parcel), with a customary right (STDM_Relationship) from the Dong people

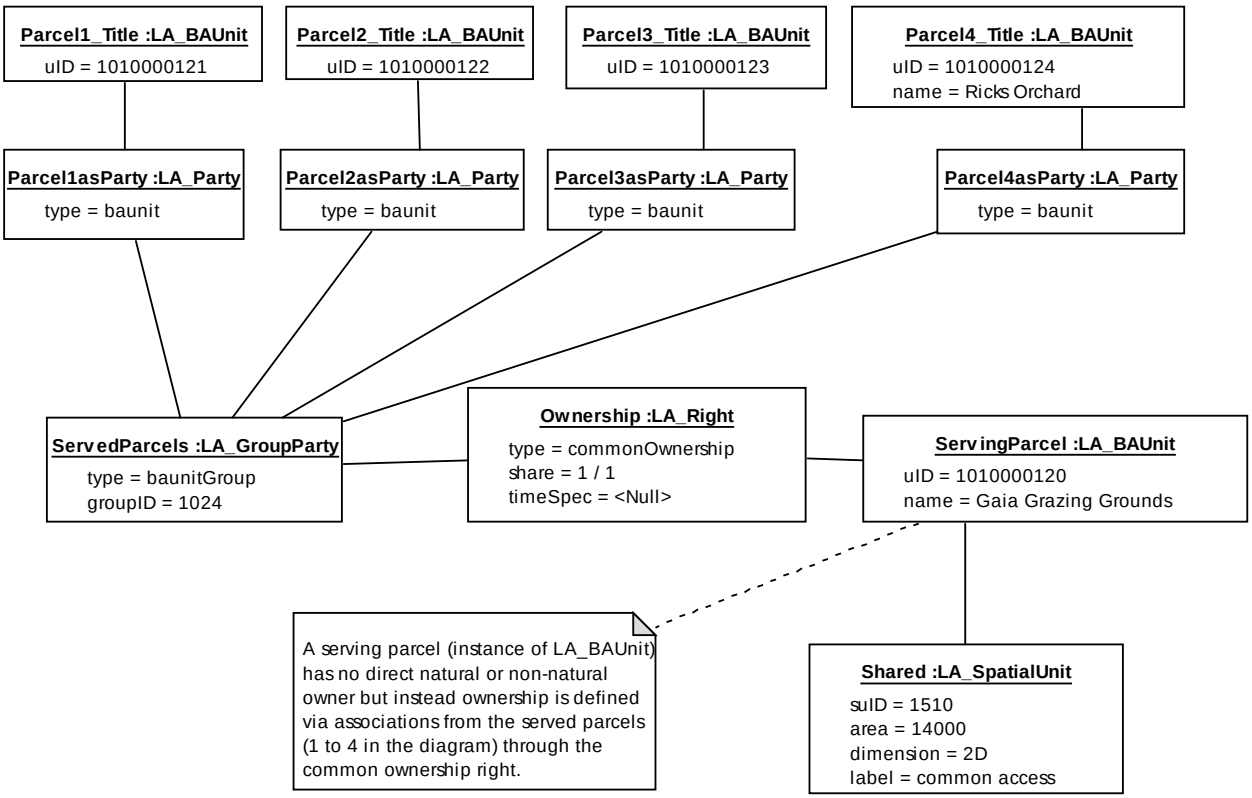


Figure C.3 — A serving parcel provides access to four parcels, and the serving parcel is not public, but commonly owned by four neighbouring parcels (*baunit as party*)

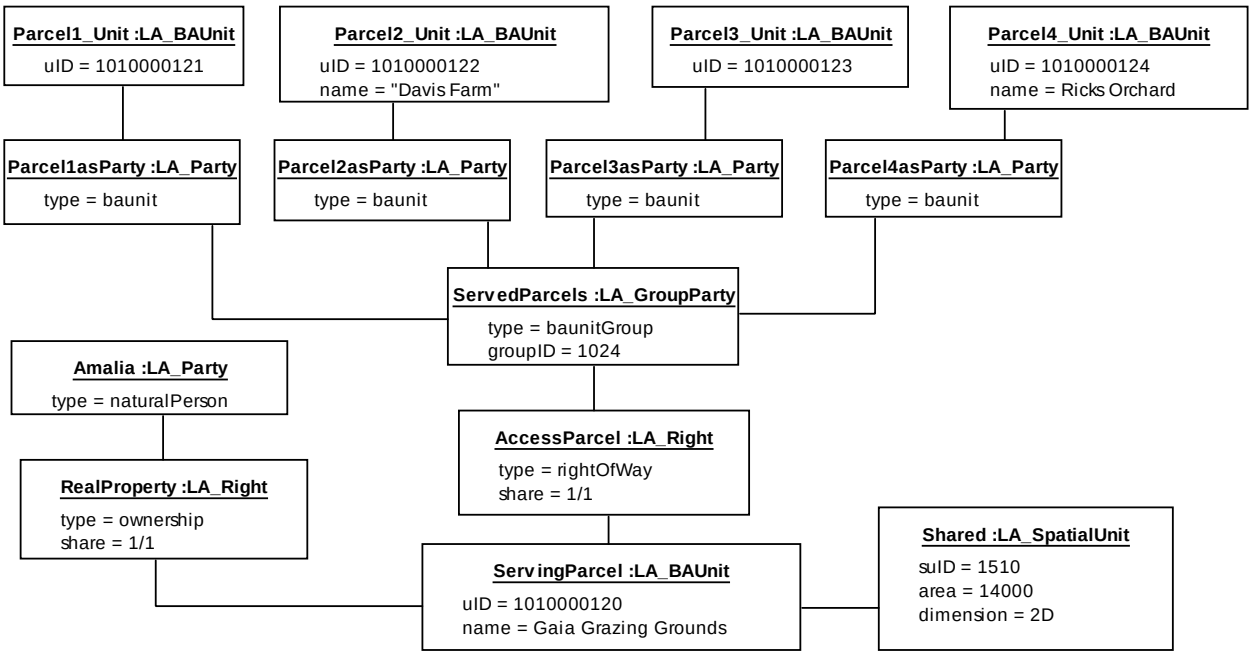


Figure C.4 — A serving parcel provides access to four parcels, and the serving parcel is not public, but owned by a fifth party. The four neighbouring parcels have right-of-way

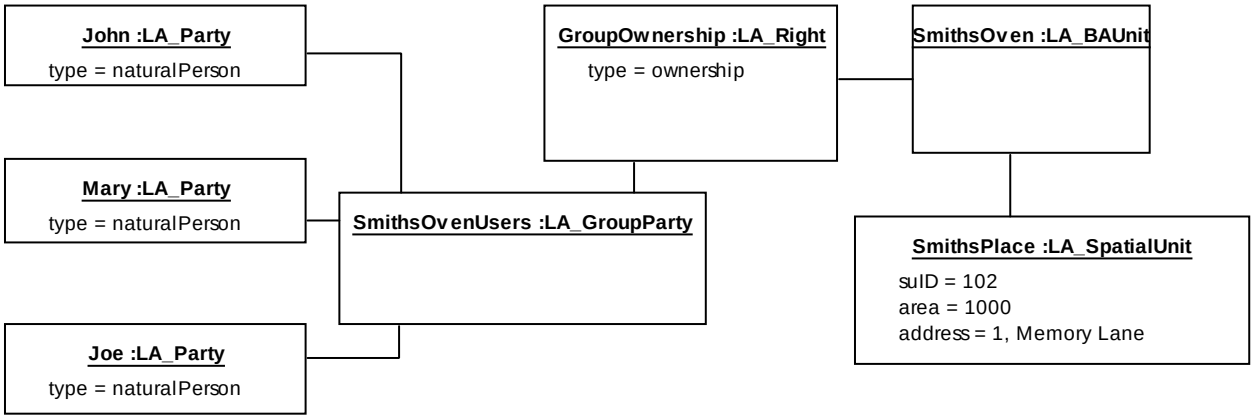


Figure C.5 — A group party holds an ownership right on a parcel

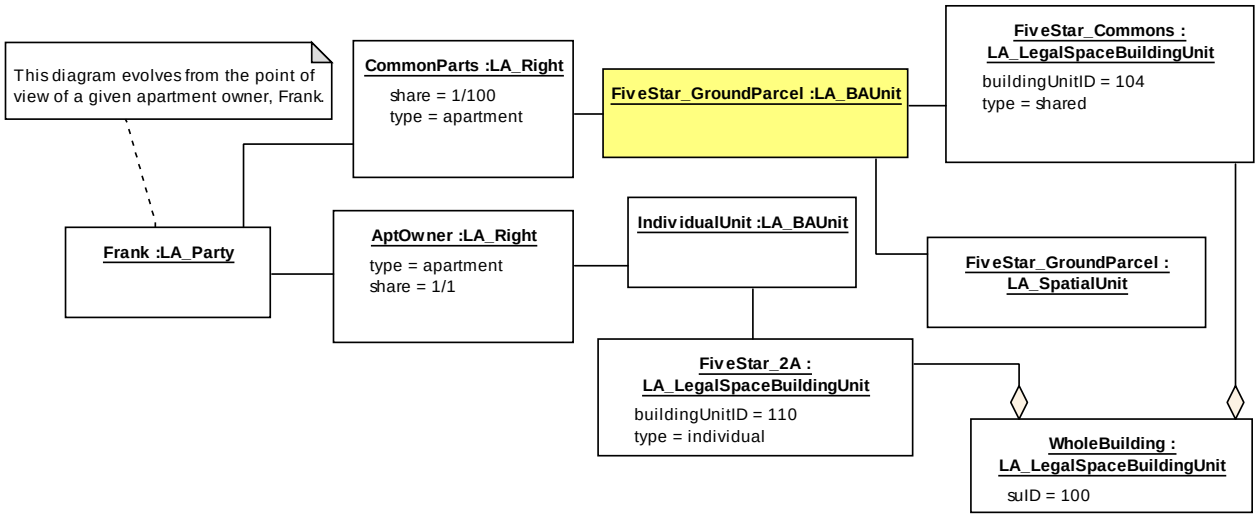


Figure C.6 — A building contains individual units (apartments), a shared unit with a common threshold (entrance), and a ground parcel. Each unit owner holds a share in the shared unit and the ground parcel

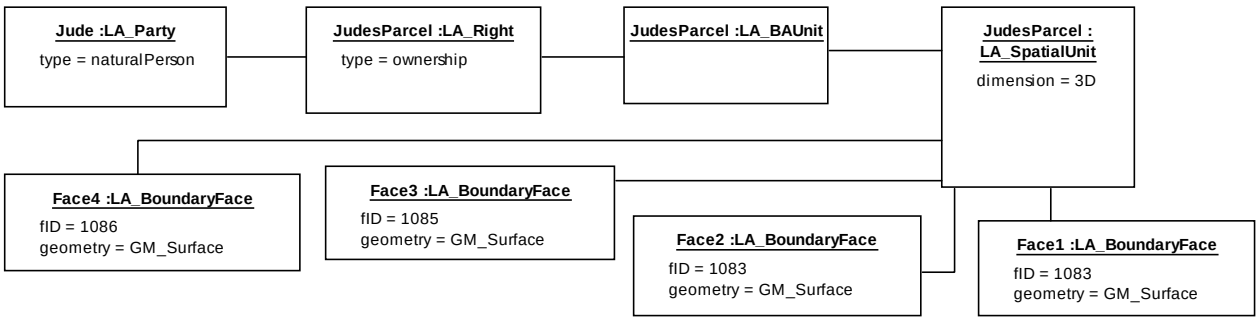


Figure C.7 — An owner with a 3D volume spatial

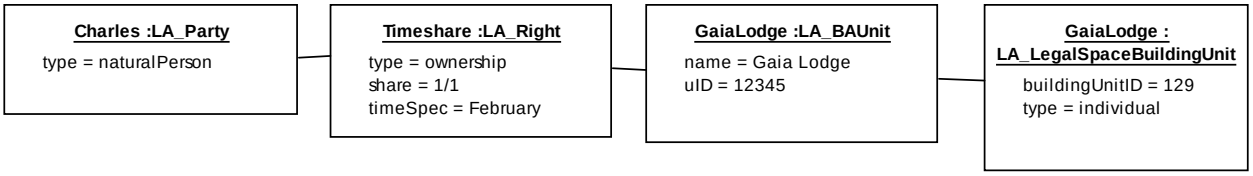


Figure C.8 — A timeshare ownership for the month of February (owners during other months are not displayed)

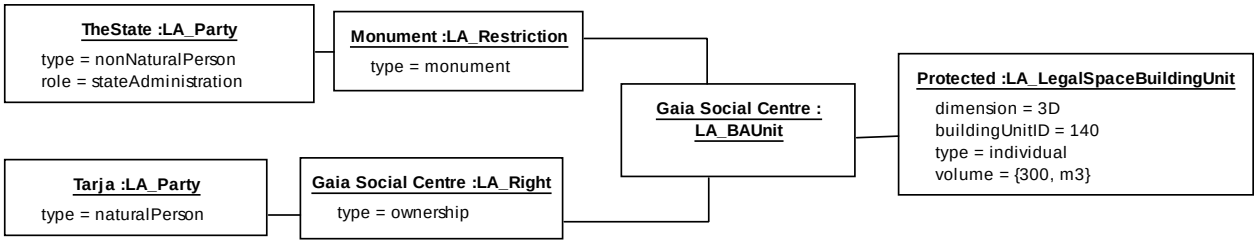


Figure C.9 — A restriction not to change a building because of its monumental status

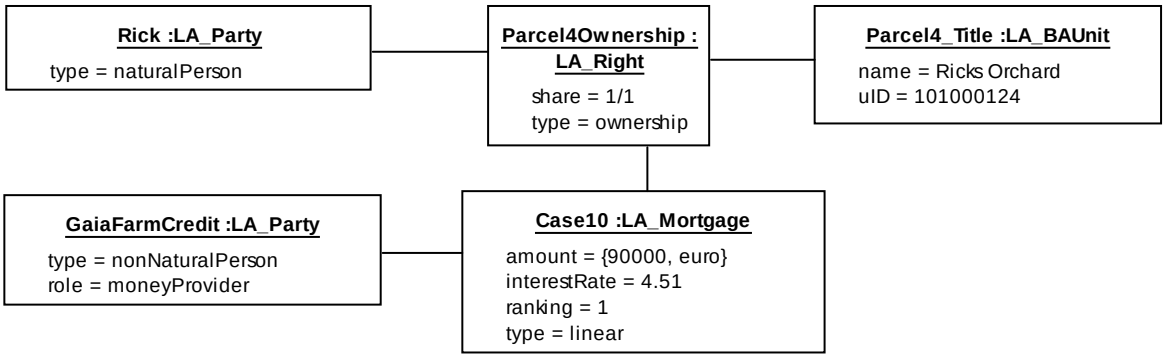


Figure C.10 — Mortgage on ownership, bank included as party

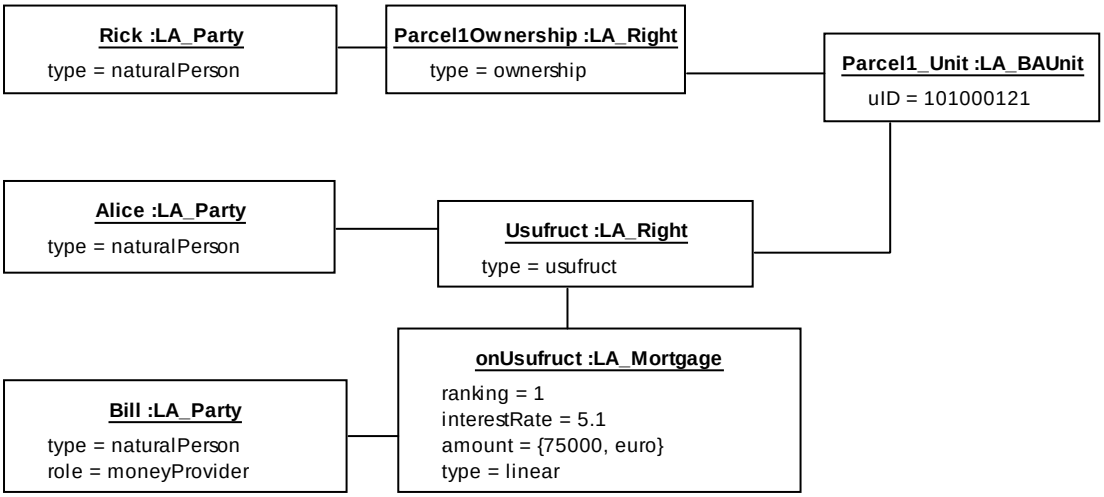


Figure C.11 — Mortgage on usufruct of ownership, money provider included as party

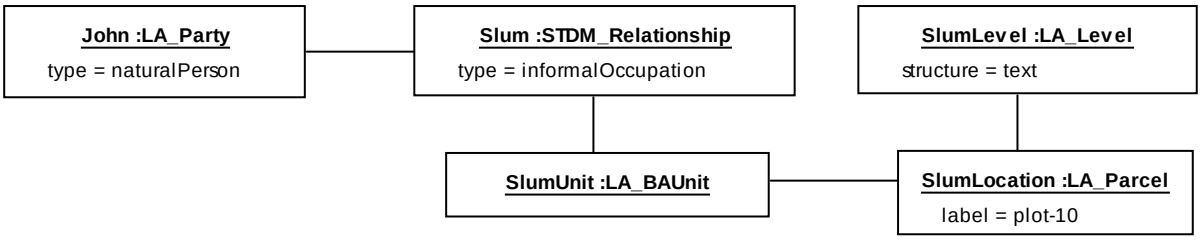


Figure C.12 — Informal right by a party (natural person) on a text spatial unit

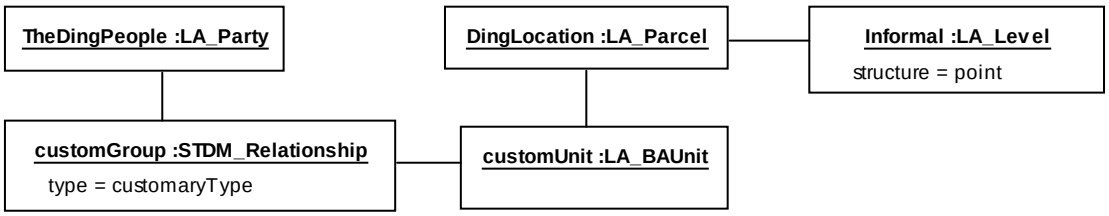


Figure C.13 — Informal right by a group on a point spatial unit

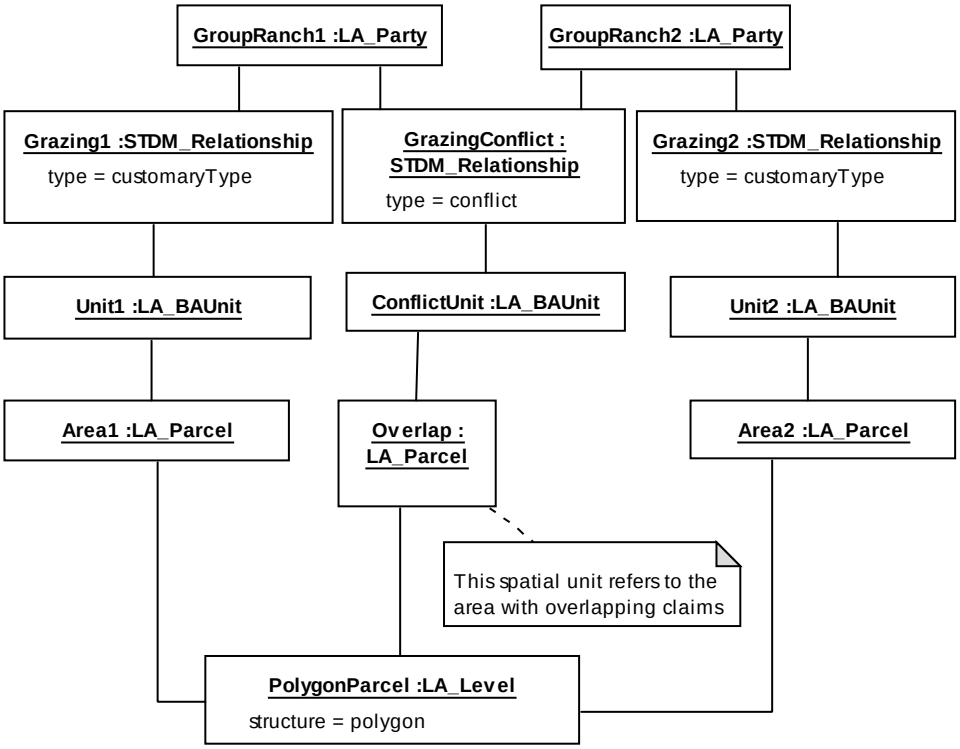


Figure C.14 — A conflicting claim on a spatial unit

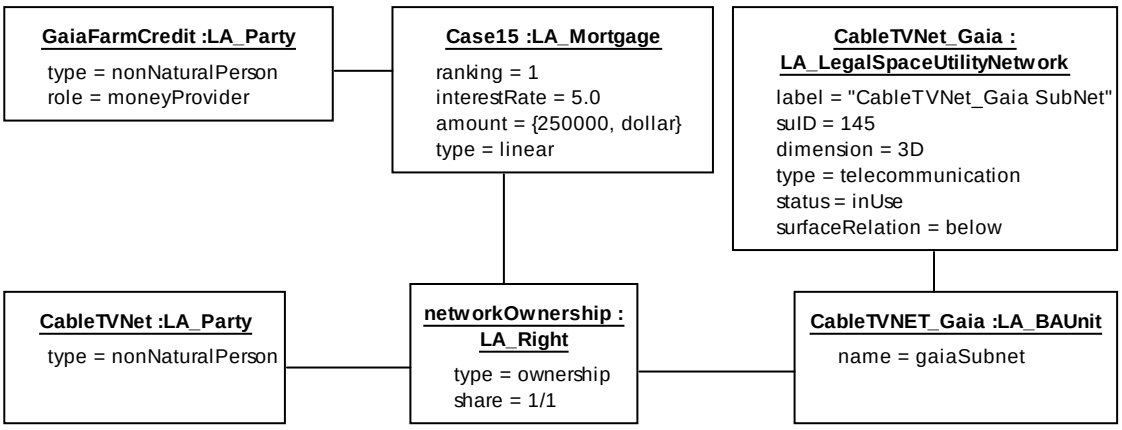


Figure C.15 — A utility network with one owner and a mortgage (bank included as party)

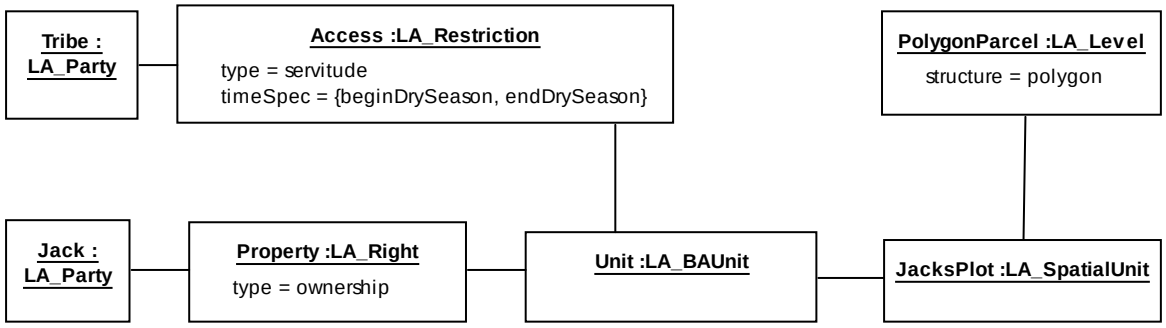


Figure C.16 — A group party (pastoralists) with an access right for a certain period of time

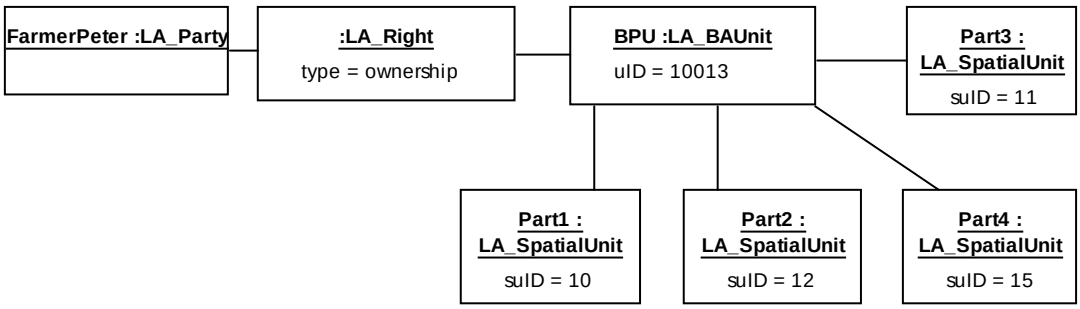


Figure C.17 — A farmer owning a basic property unit (BPU), with several spatial units (example from Finland)

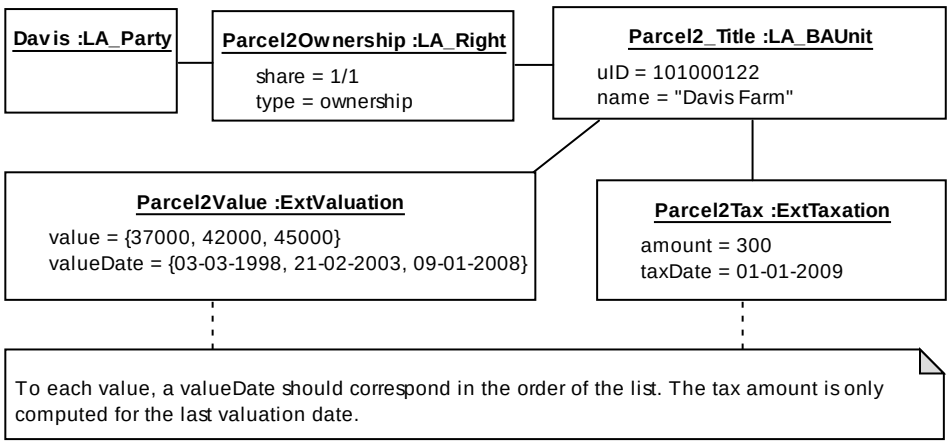


Figure C.18 — Value as basis for taxation valid for five years

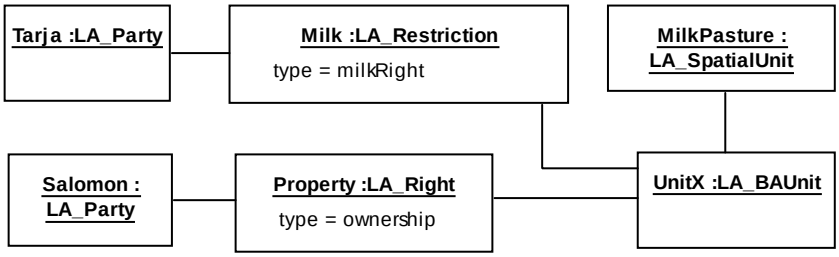


Figure C.19 — A milk right to a spatial unit

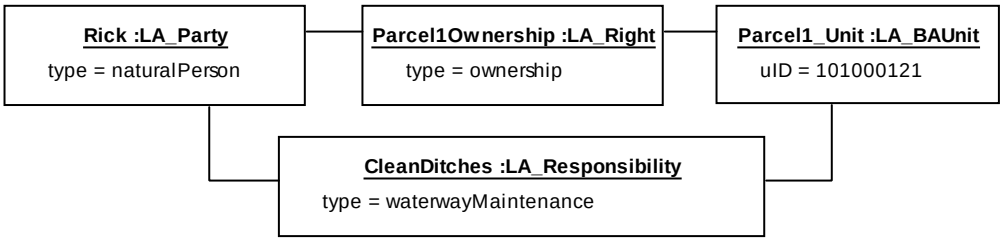


Figure C.20 — A responsibility to clean the ditches

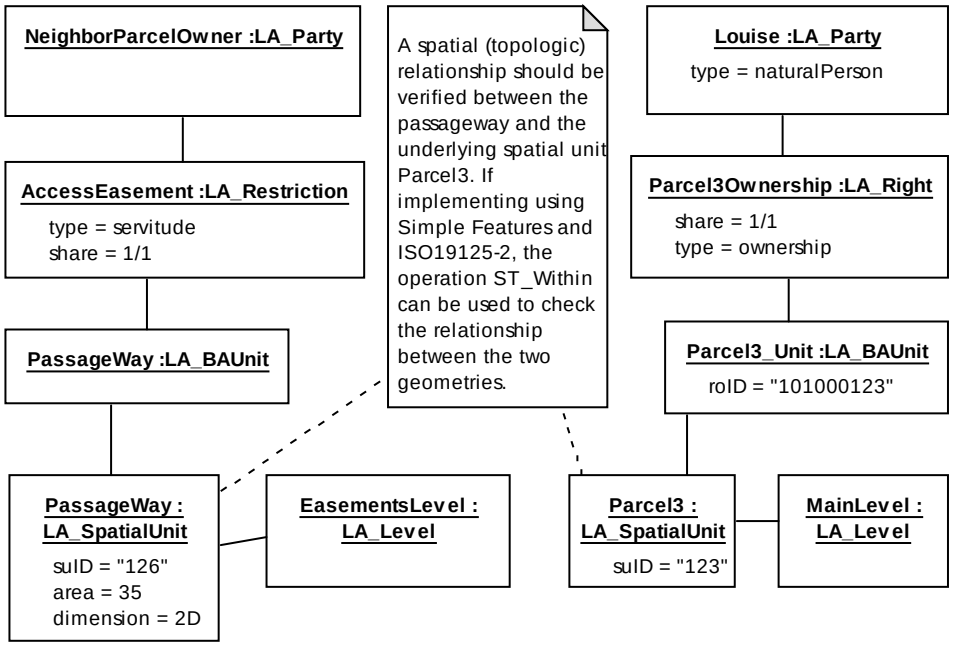


Figure C.21 — A right to use a road on a property of somebody else (I)

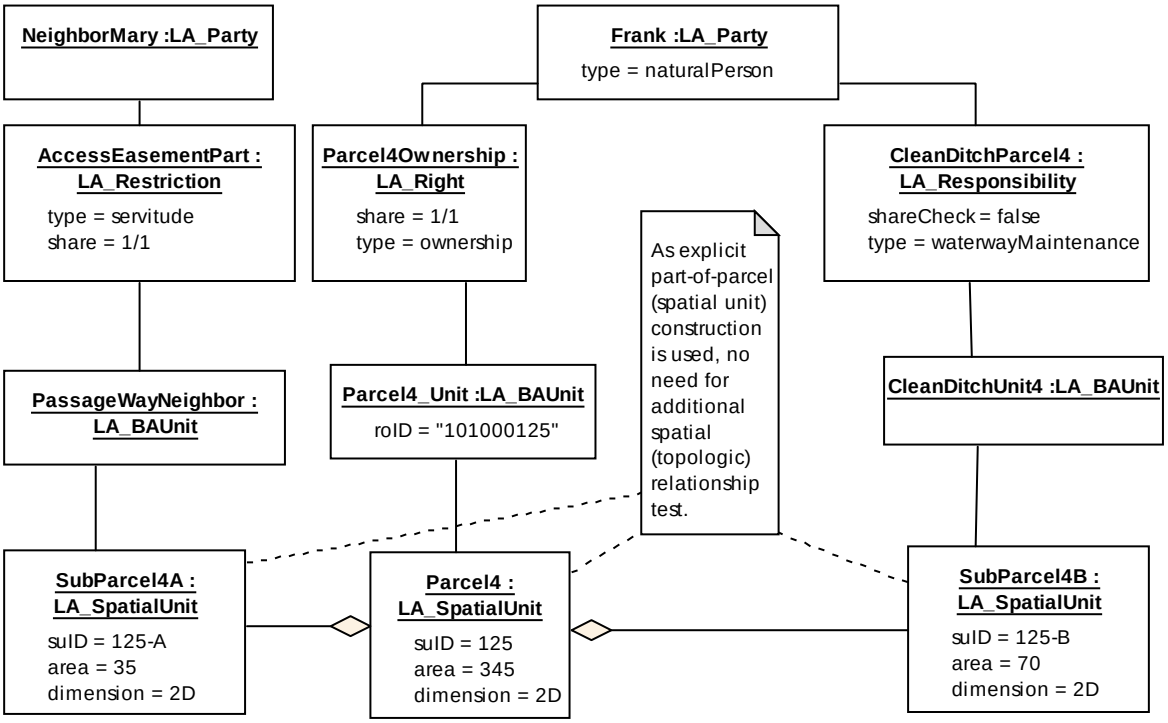


Figure C.22 — A right to use a road on a property of somebody else (II)

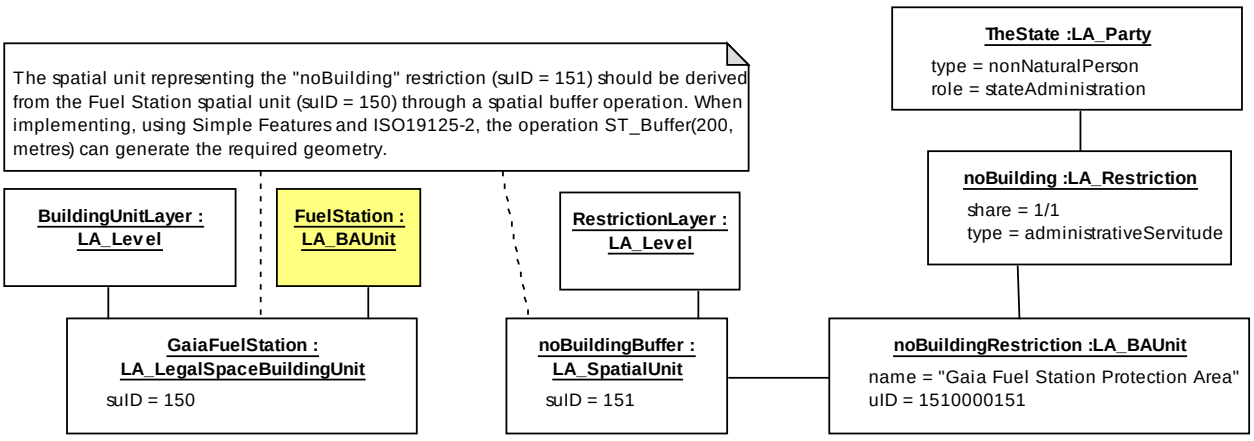


Figure C.23 — A restriction area (“it is not allowed to built within 200 metres of a fuel station”) with its own geometry

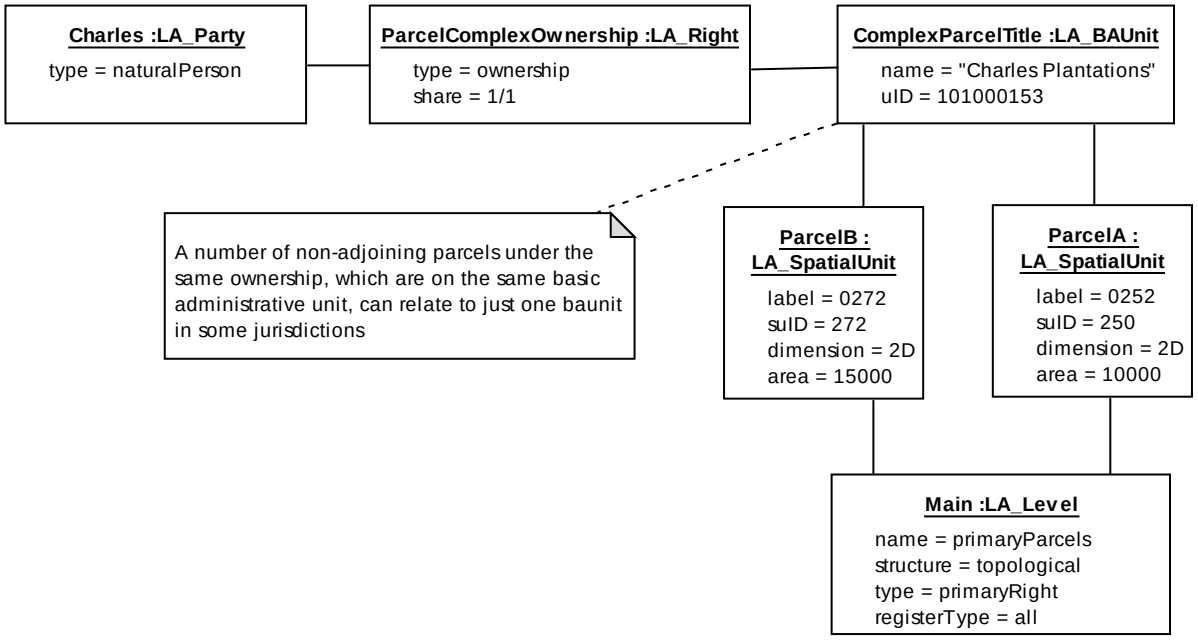


Figure C.24 — Spatial unit complex with one owner

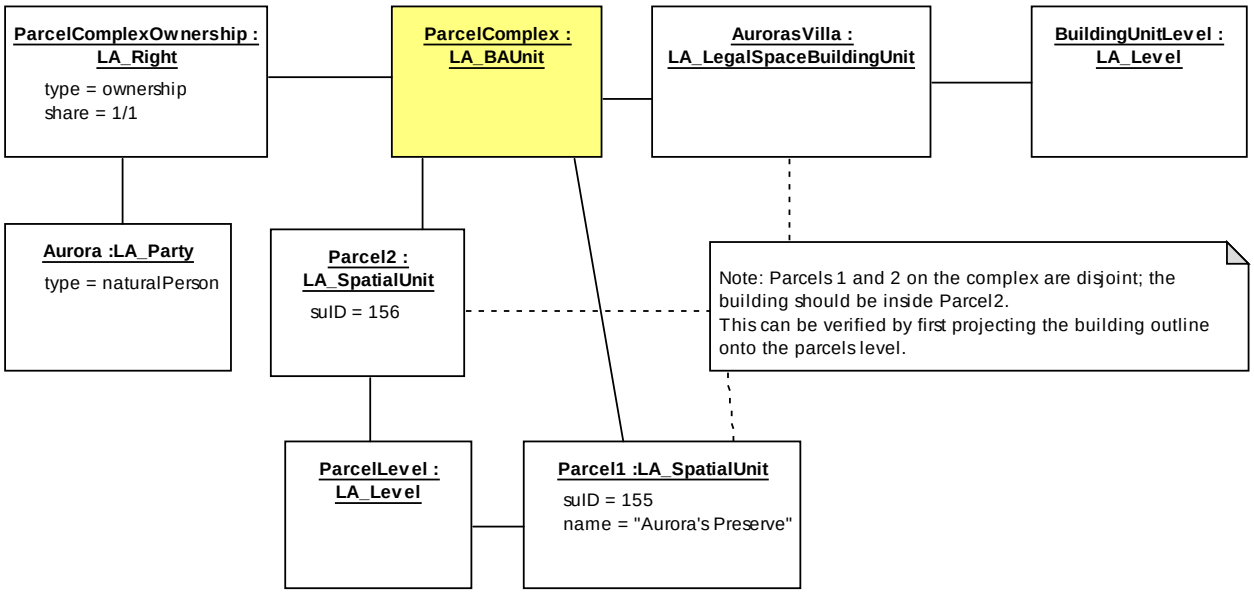


Figure C.25 — Spatial unit complex with building, from a single owner (Aurora)

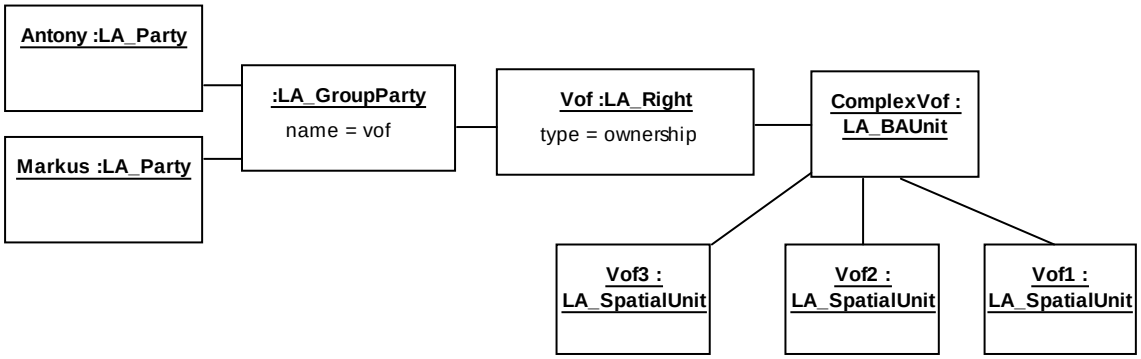


Figure C.26 — Complex of parcels with two owners

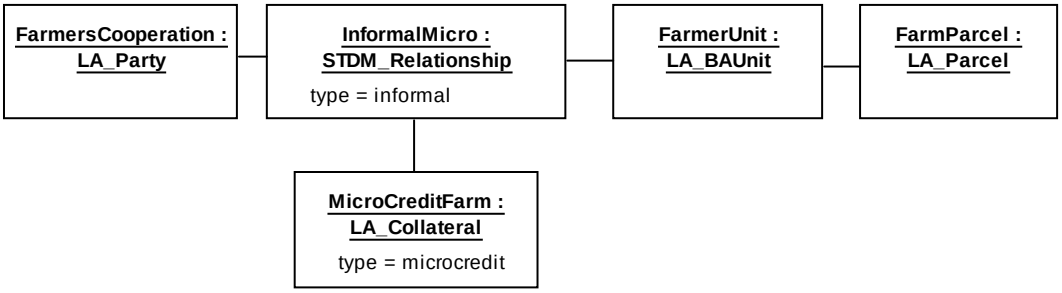


Figure C.27 — Spatial unit with micro credit

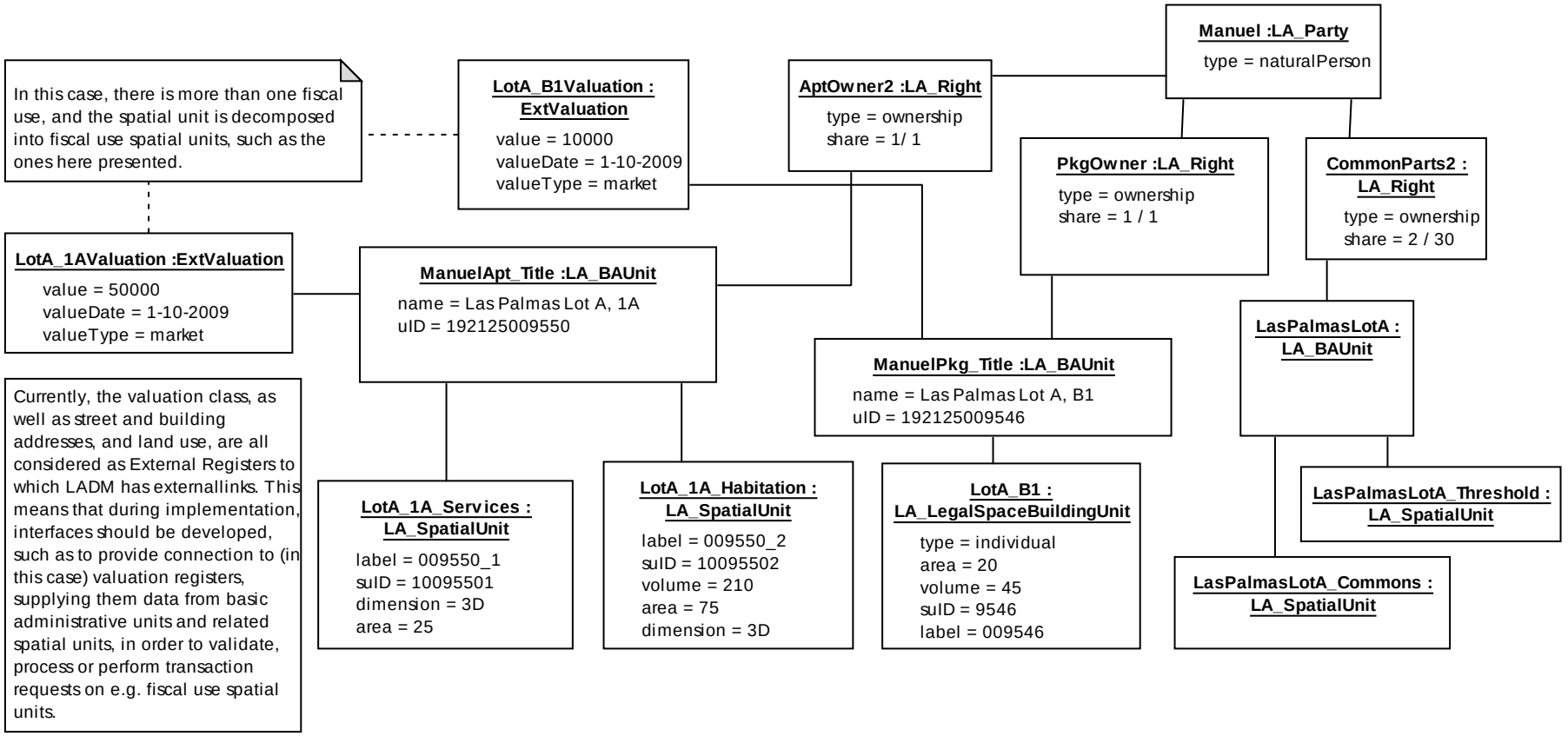


Figure C.28 — Tax valuations on condominium rights in Spain. An owner of a building unit and related common and individual parts is subject to a total tax amount, computed from sub-areas under uniform fiscal categories of use

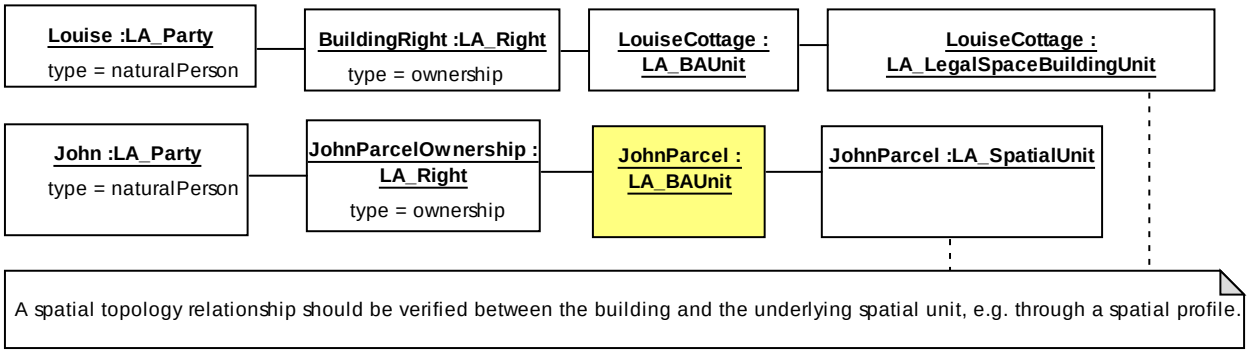


Figure C.29 — A spatial unit with one owner, with a building from a different owner

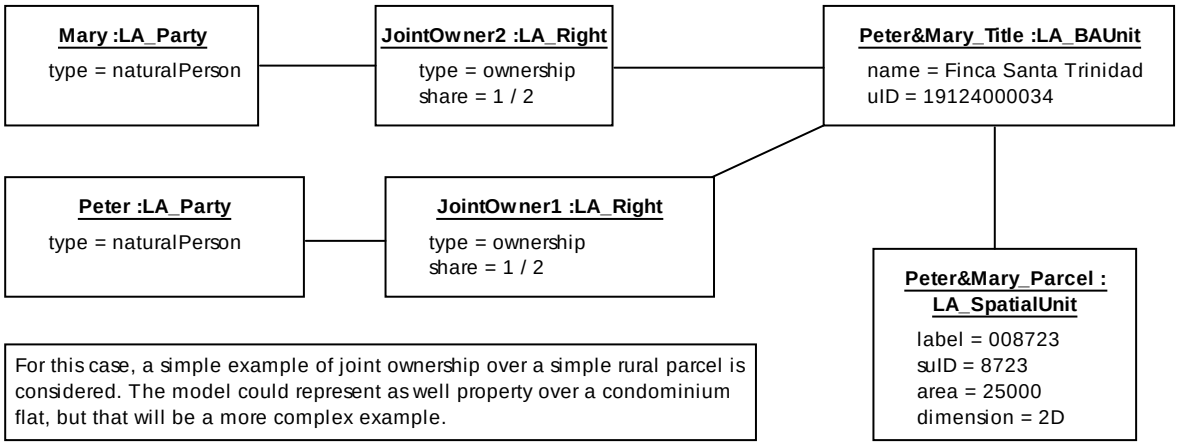
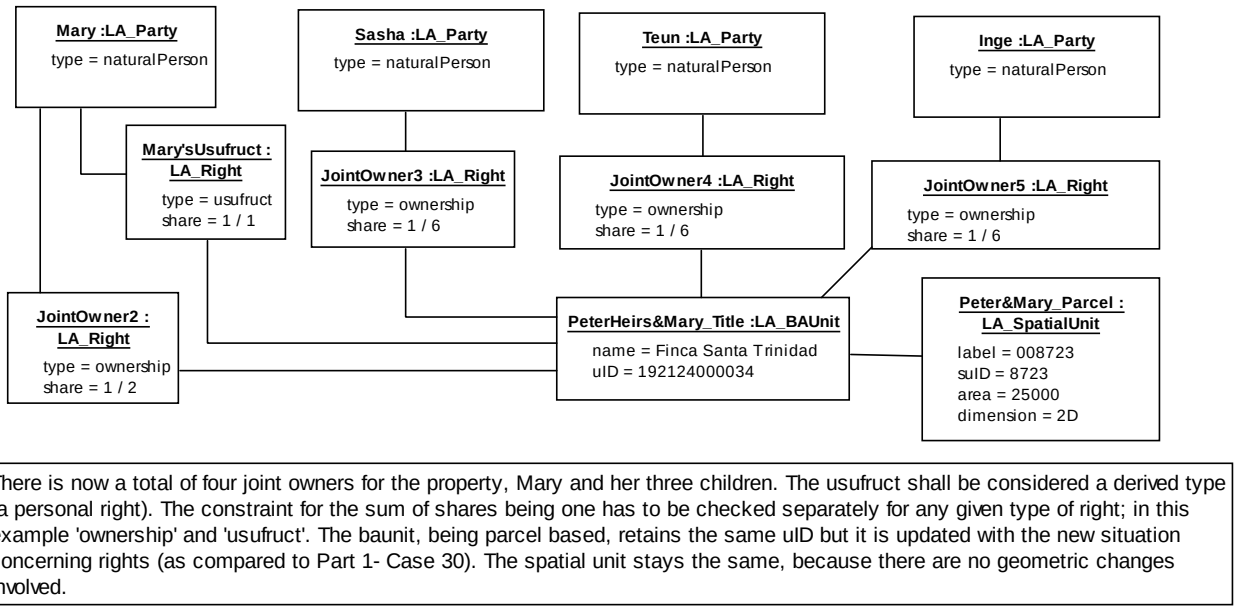


Figure C.30 — Marriage and inheritance relationships to property (simple) in Spain (Part 1). A married couple owns a property with equal shares



There is now a total of four joint owners for the property, Mary and her three children. The usufruct shall be considered a derived type (a personal right). The constraint for the sum of shares being one has to be checked separately for any given type of right; in this example 'ownership' and 'usufruct'. The baunit, being parcel based, retains the same uID but it is updated with the new situation concerning rights (as compared to Part 1- Case 30). The spatial unit stays the same, because there are no geometric changes involved.

Figure C.31 — Marriage and inheritance relationships to property (complex) in Spain (Part 2). After Peter has died, he leaves an usufruct right from his share to Mary, who still holds her half share of the property. Their three children, Sasha, Teun and Inge, all inherit an equal share of Peter's part.

This case extends the generic LADM, considering one of the mechanisms available for individual country models, namely adding their specific type categories into code values and enumerations. In this case, the registerType receives a new "ES_special" type.

Furthermore, the LA_BAUnit instance relates to a number of distinct parcels, which can be spatially disjoint. Although such parcels are disjoint, they belong to the full partition of (2D) space, that could be verified topologically.

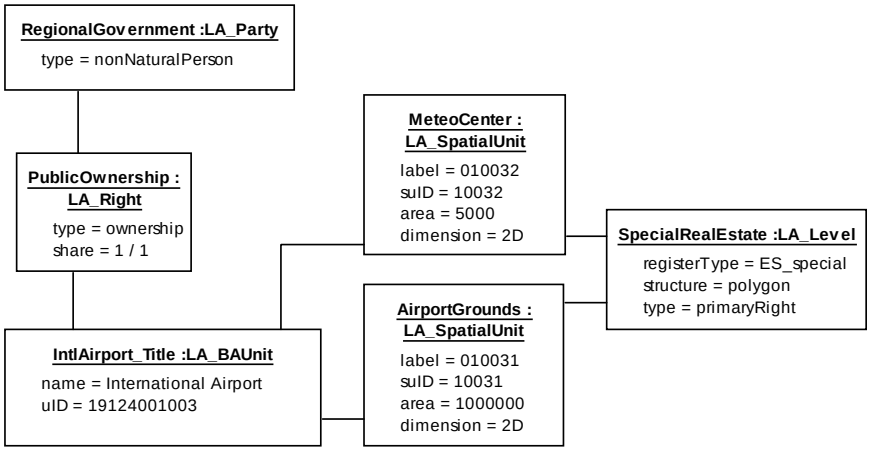


Figure C.32 — Spanish 'special real estate' form of property. The Spanish Cadastre distinguishes between two basic categories: urban real estate and rural real estate. A third residual category exists for special real estates, whose characteristics require different treatment, namely with regard to assessment. The example is focused on an airport

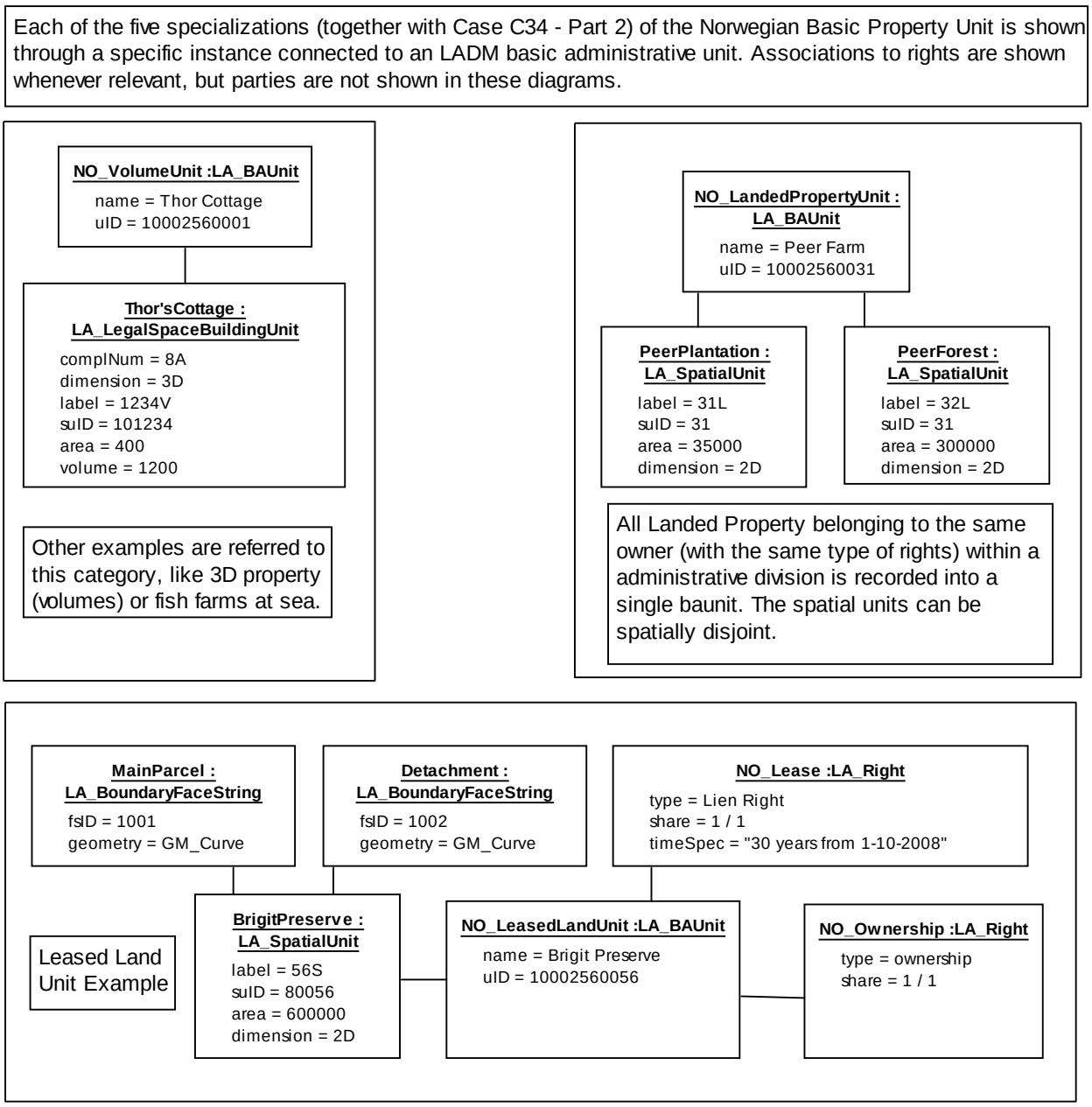


Figure C.33 — Norwegian categories of basic property units (Part 1). Examples for Volume Unit, Landed Property and Leased Land Unit

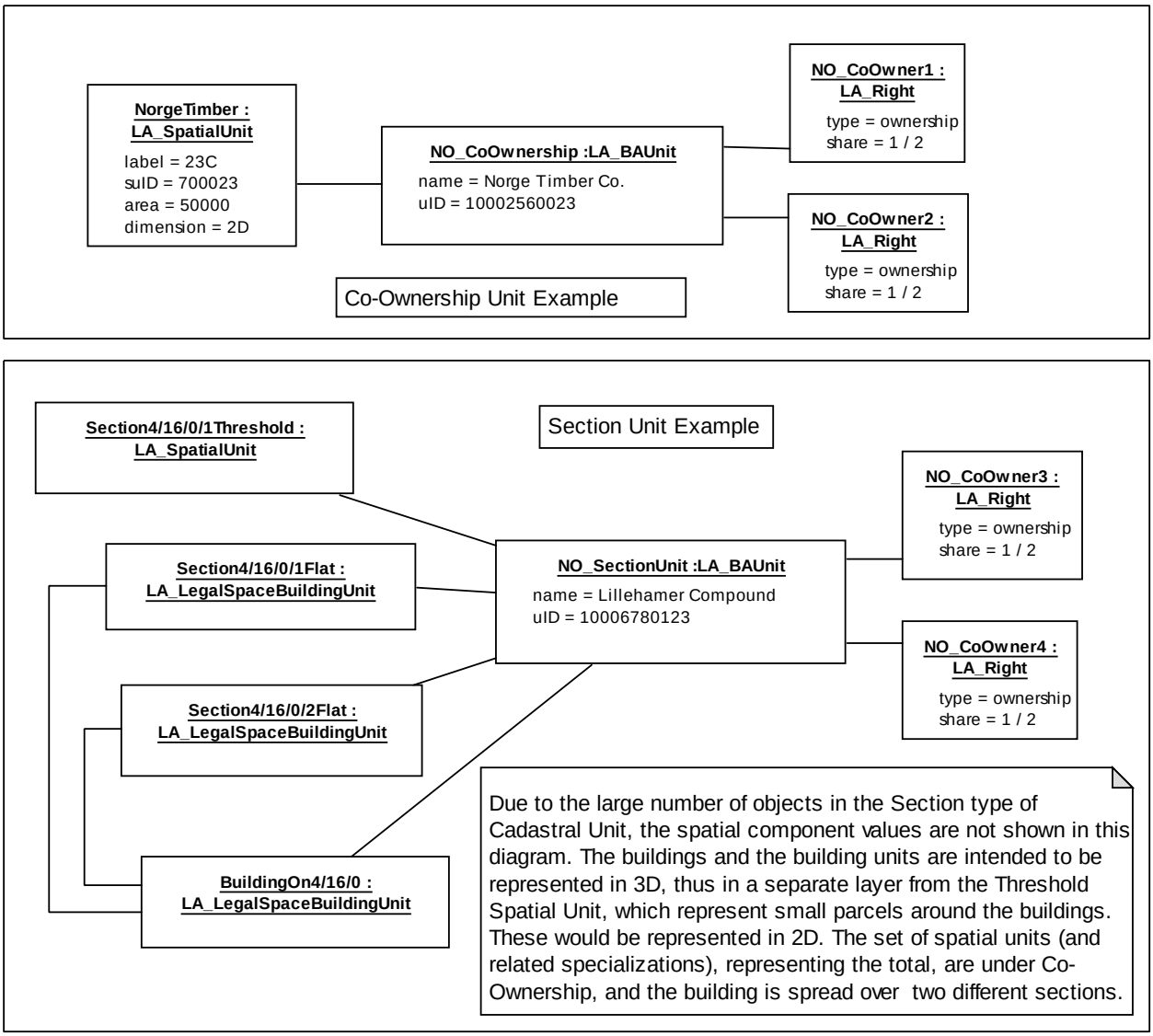


Figure C.34 — Norwegian categories of basic property units (Part 2). Examples for a Co-Ownership Unit and a Section Unit

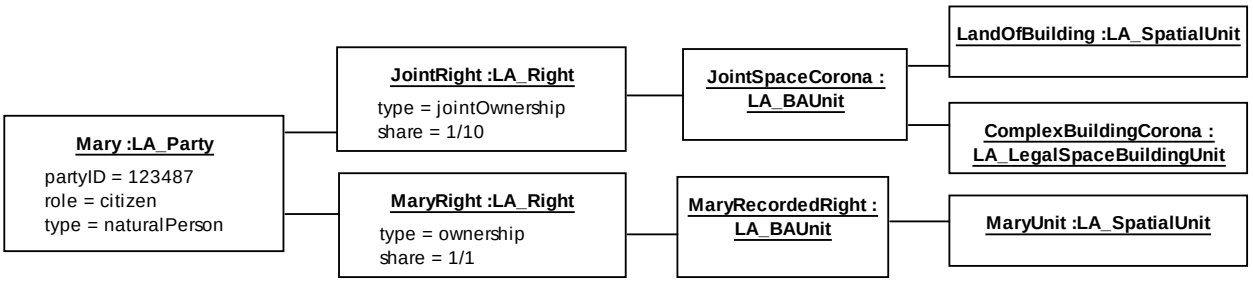


Figure C.35 — Individual and joint property rights in Spain ('Corona' is the building name)

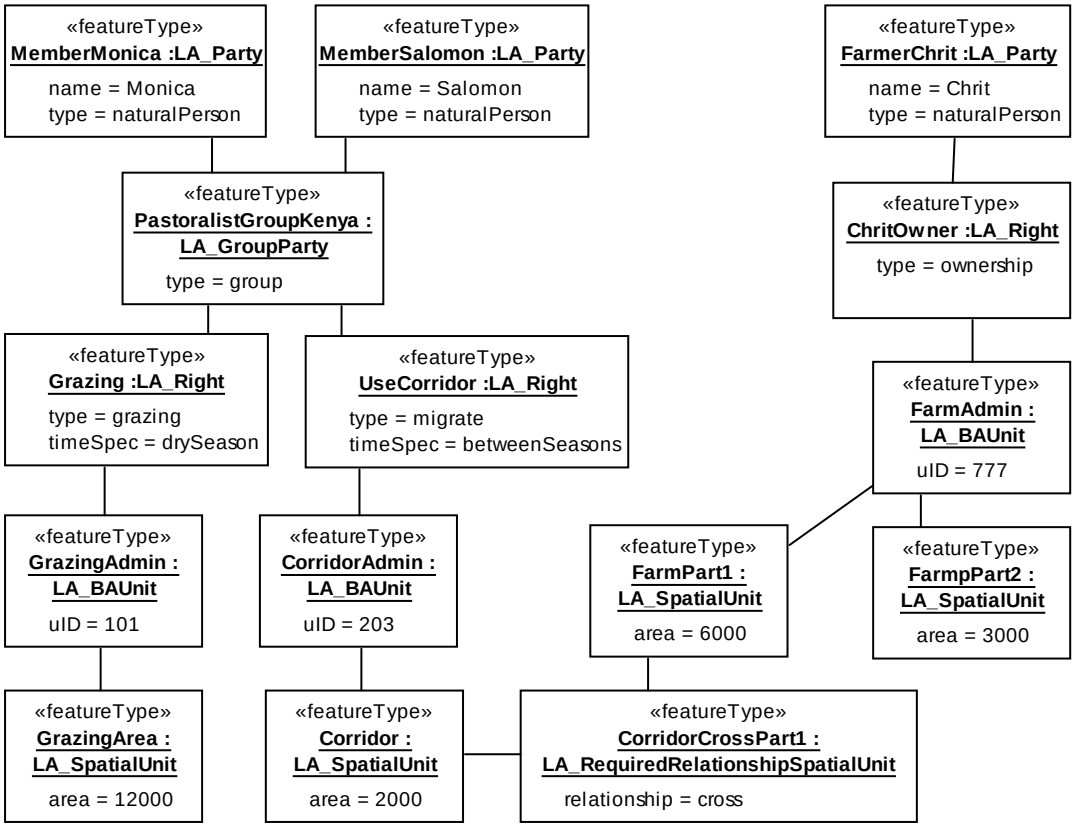


Figure C.36 — Grazing rights of pastoralists in Kenya. A pastoralist group in Kenya has two different kinds of rights: 1. a right to migration corridors (these can pass through farmers land), and 2. a right to access grazing areas for a longer period of time

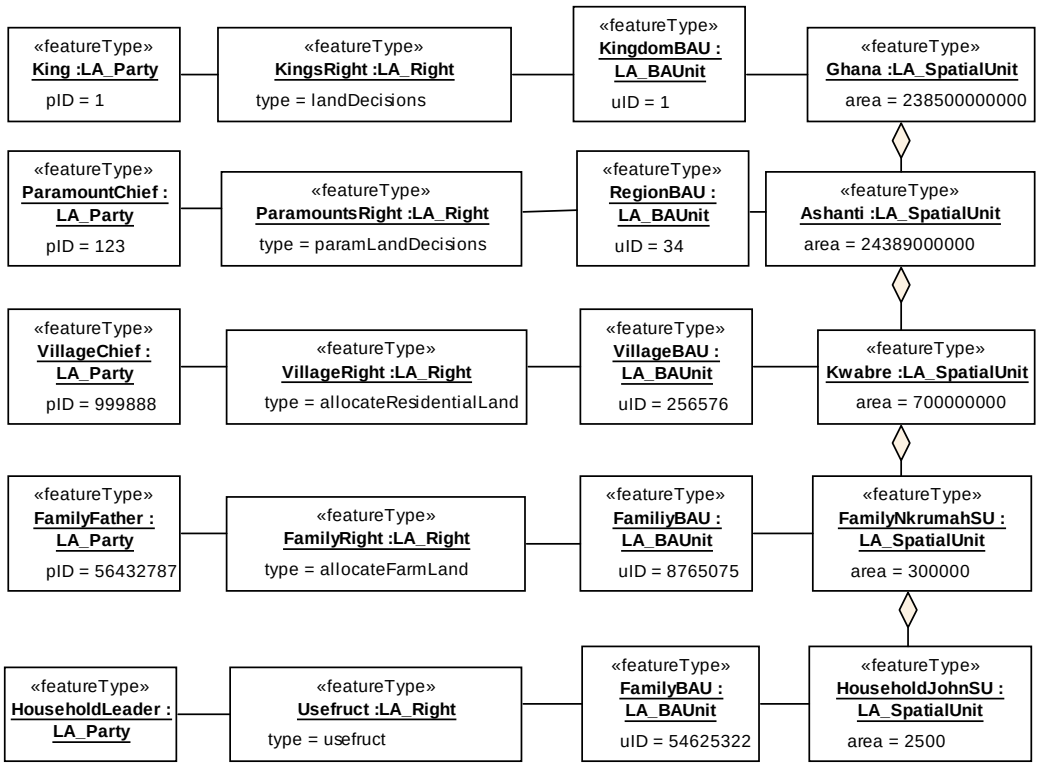


Figure C.37 — Customary rights in Ghana. The Ghana customary rights are based on an hierarchy of parties (King, Paramount Chief, Village Chief, Family Head, and Household Head), RRRs and BA/Spatial Units (Kingdom, Region, Village, Family SU, and Household SU)

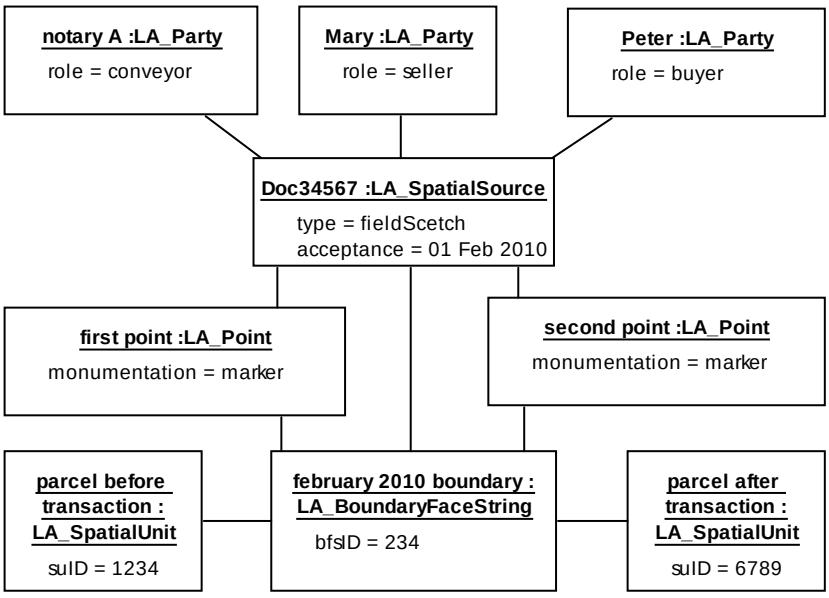


Figure C.38 — An accepted subdivision, resulting in parcel A and parcel B. Notary A prepared an ownership transaction, described in the transaction deed, which has been accepted by the LA organization

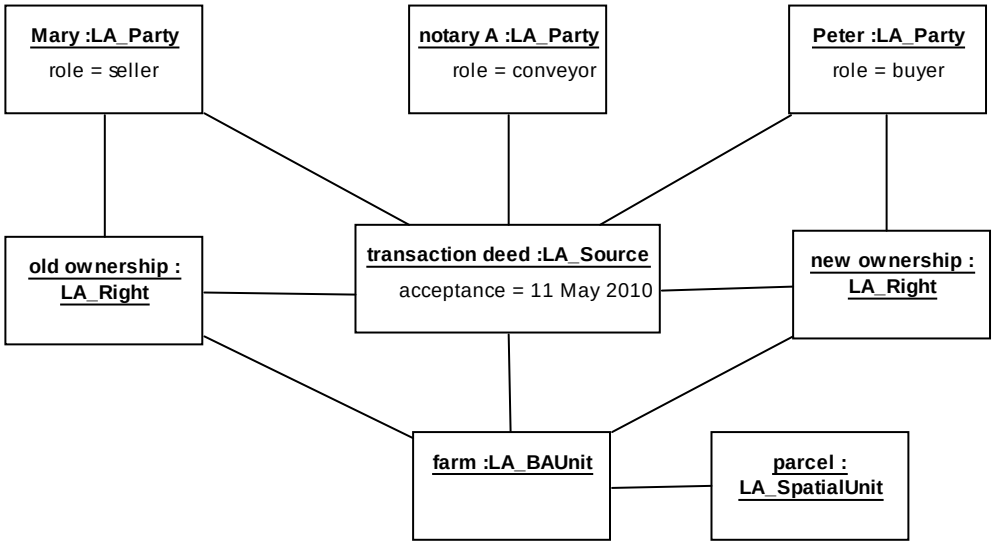


Figure C.39 —Buying and selling of a spatial unit. Notary A prepared an ownership transaction, described in the transaction deed, which has been accepted by the LA organization

Annex D
(informative)

Country Profiles

In this Annex six country profiles of LADM are mentioned:

1) Portugal (Figures D.1 and D.2).
2) Queensland, Australia (Figure D.3).
3) Indonesia (Figure D.4).
4) Japan (Figure D.5).
5) Hungary (Figure D.6).
6) The Netherlands (Figure D.7).

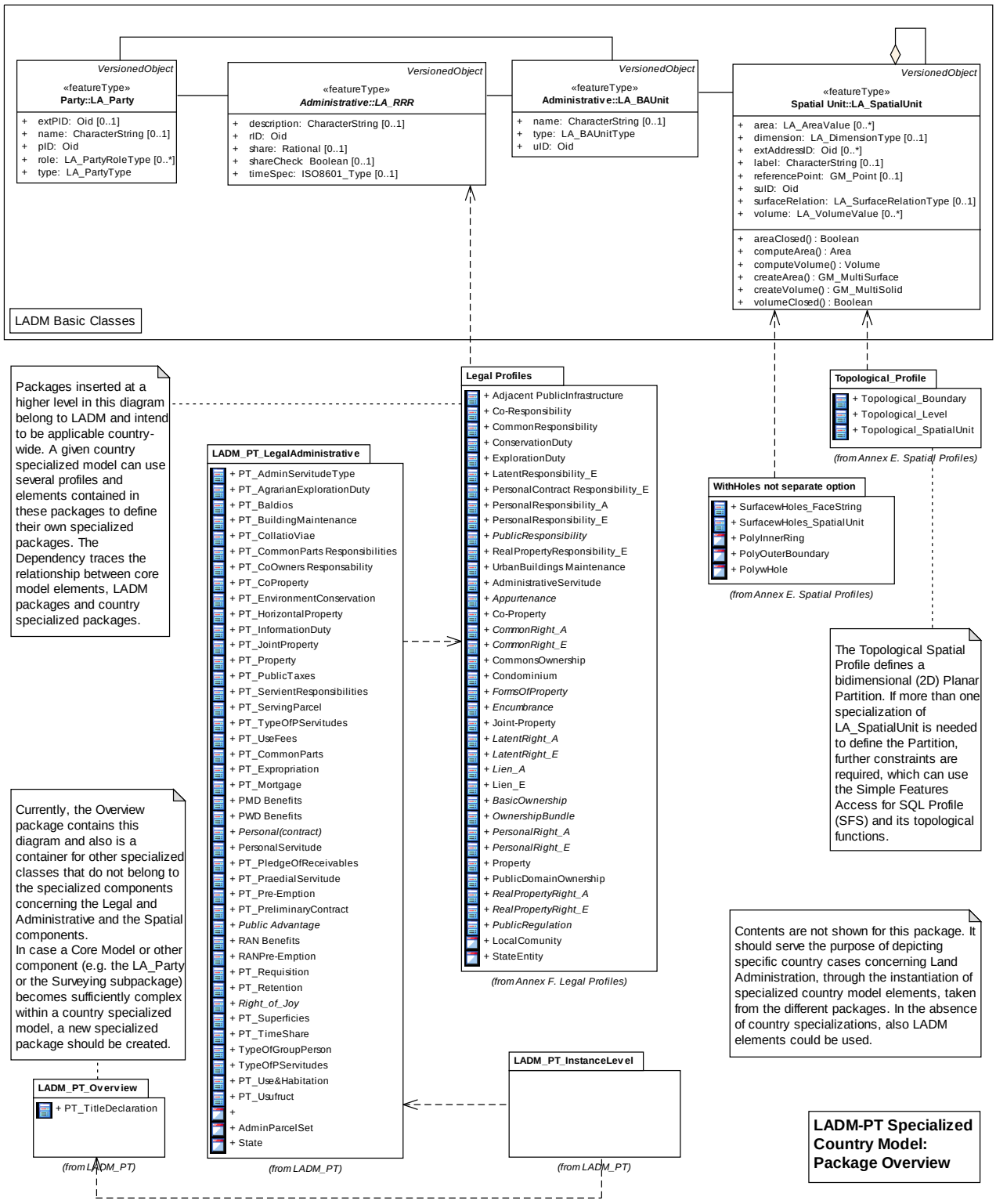


Figure D.1 — Country profile Portugal – Package Overview

NOTE 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.

The complete country profile for Portugal includes a number of class diagrams, from which the most relevant are presented here: the package overview (Figure D.1) 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 (Figure E.5) and 2D Polygon (Figure E.4). 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.

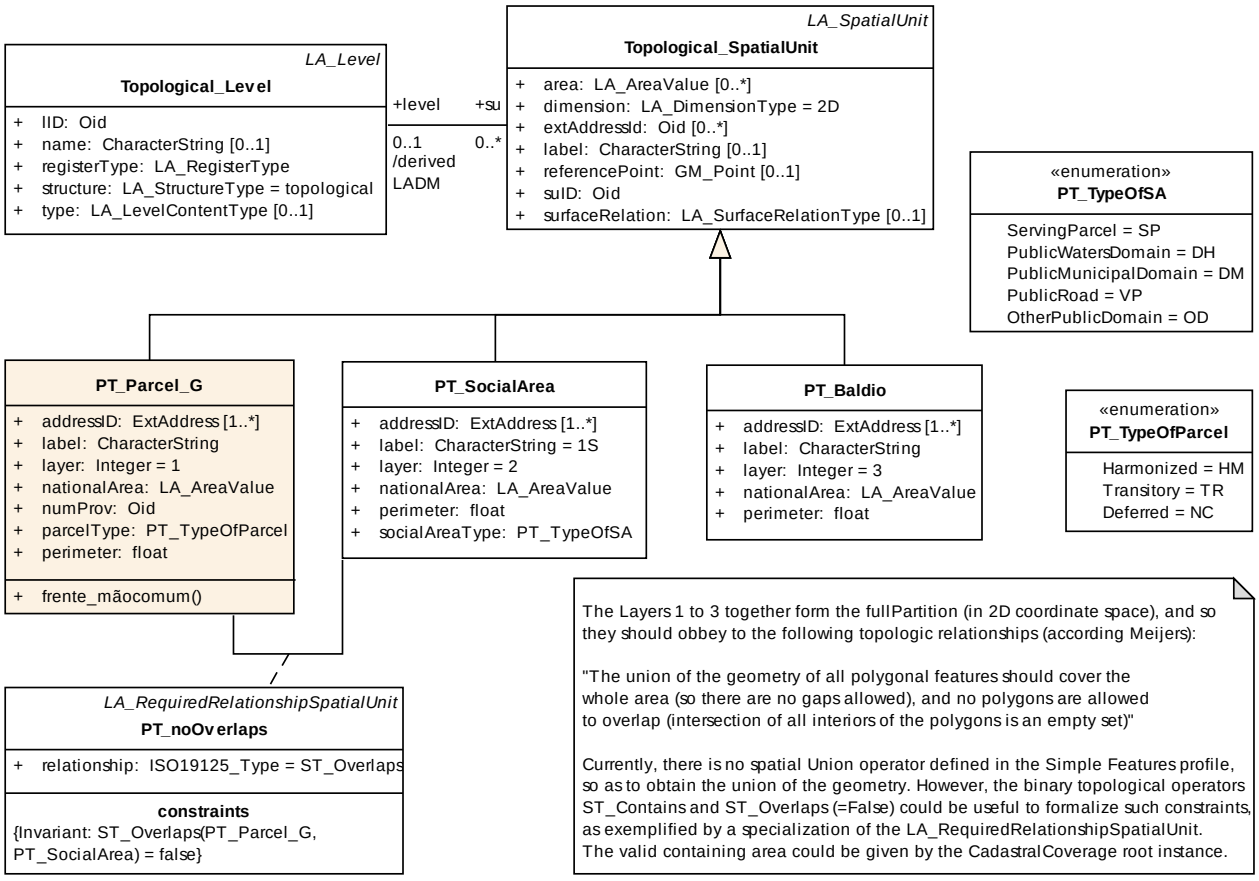


Figure D.2 — Country profile Portugal – Specializations of Spatial Unit

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 legally 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.

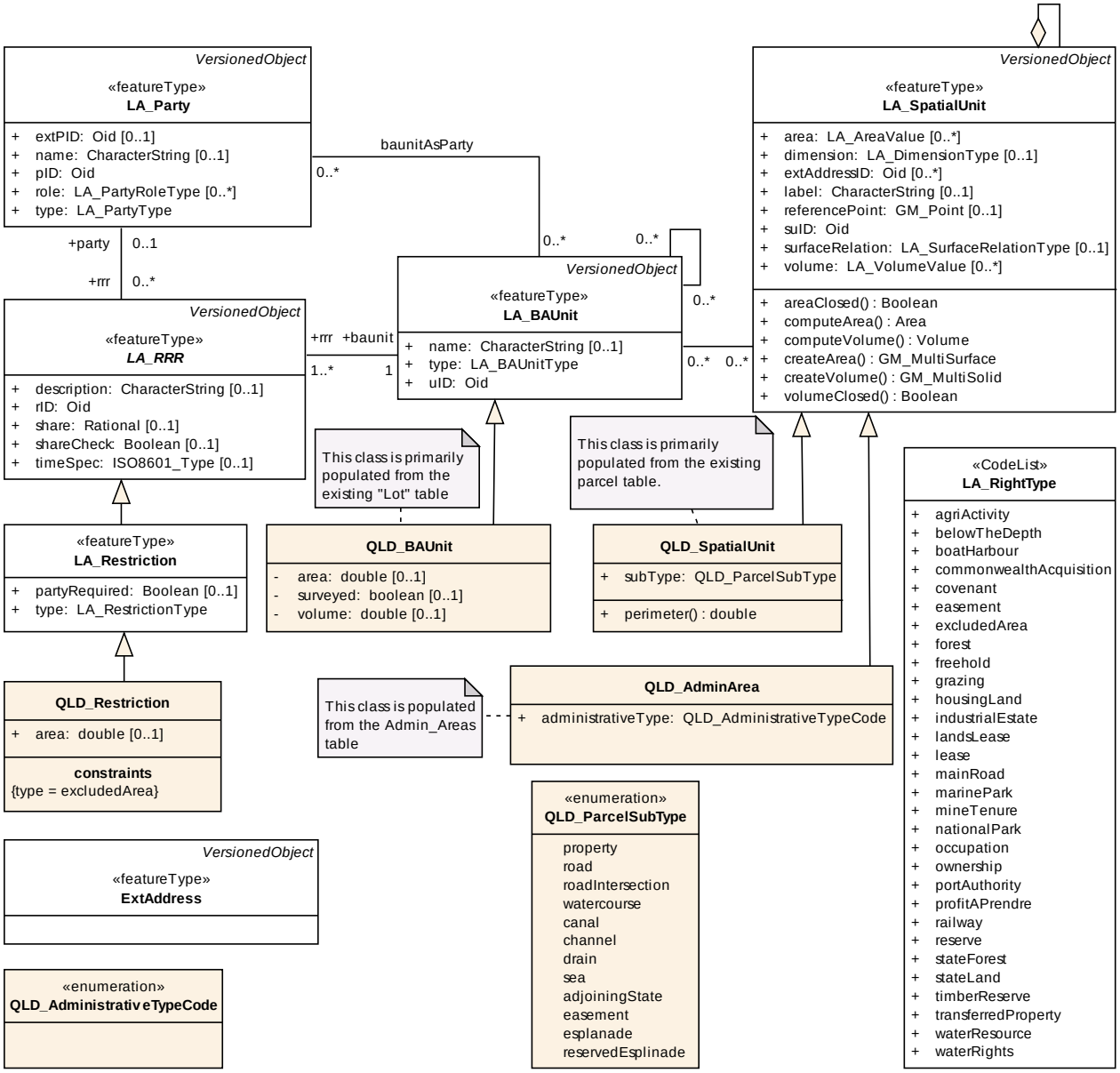


Figure D.3 — Country profile Queensland, Australia

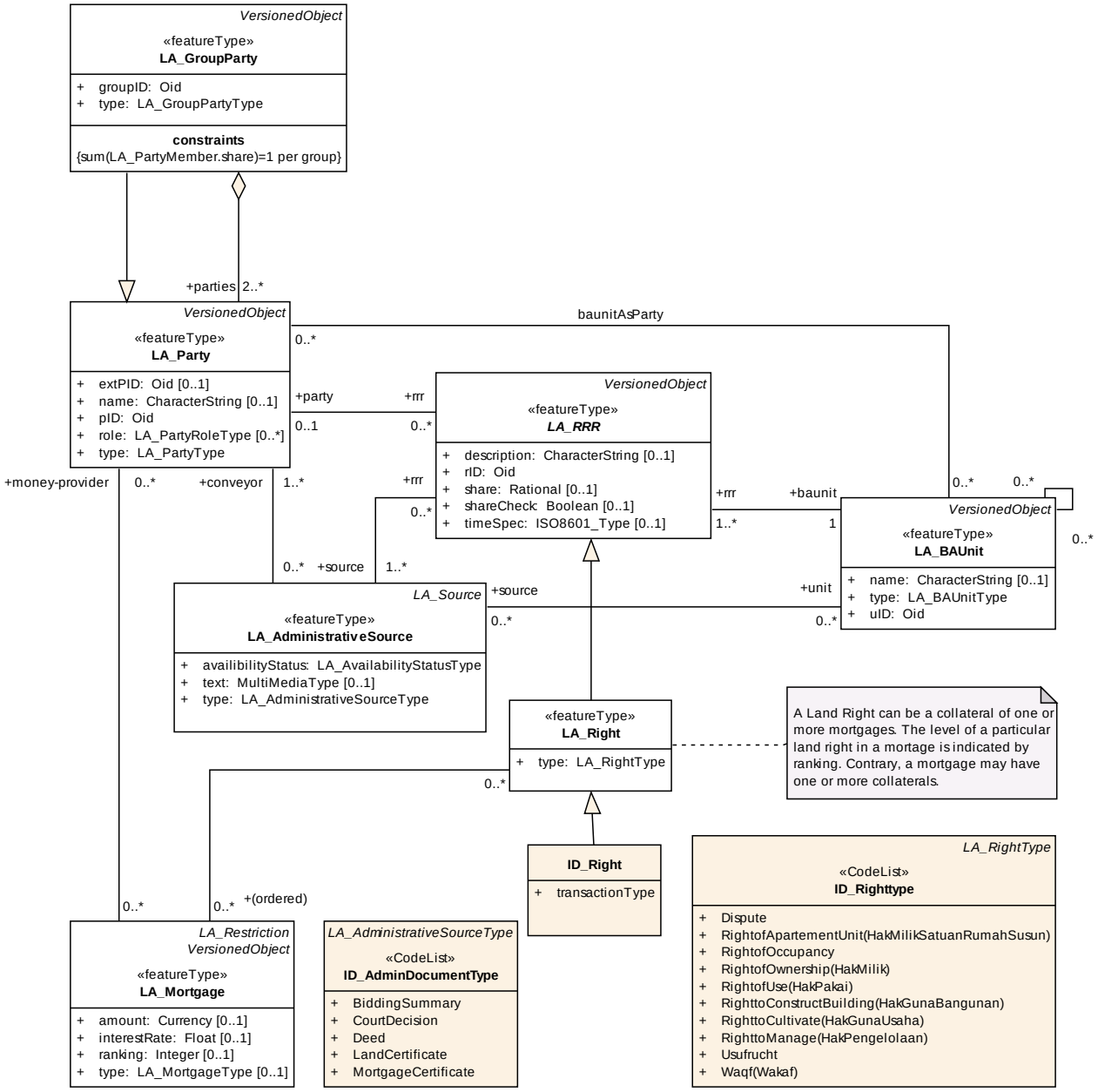


Figure D.4 — Country profile Indonesia

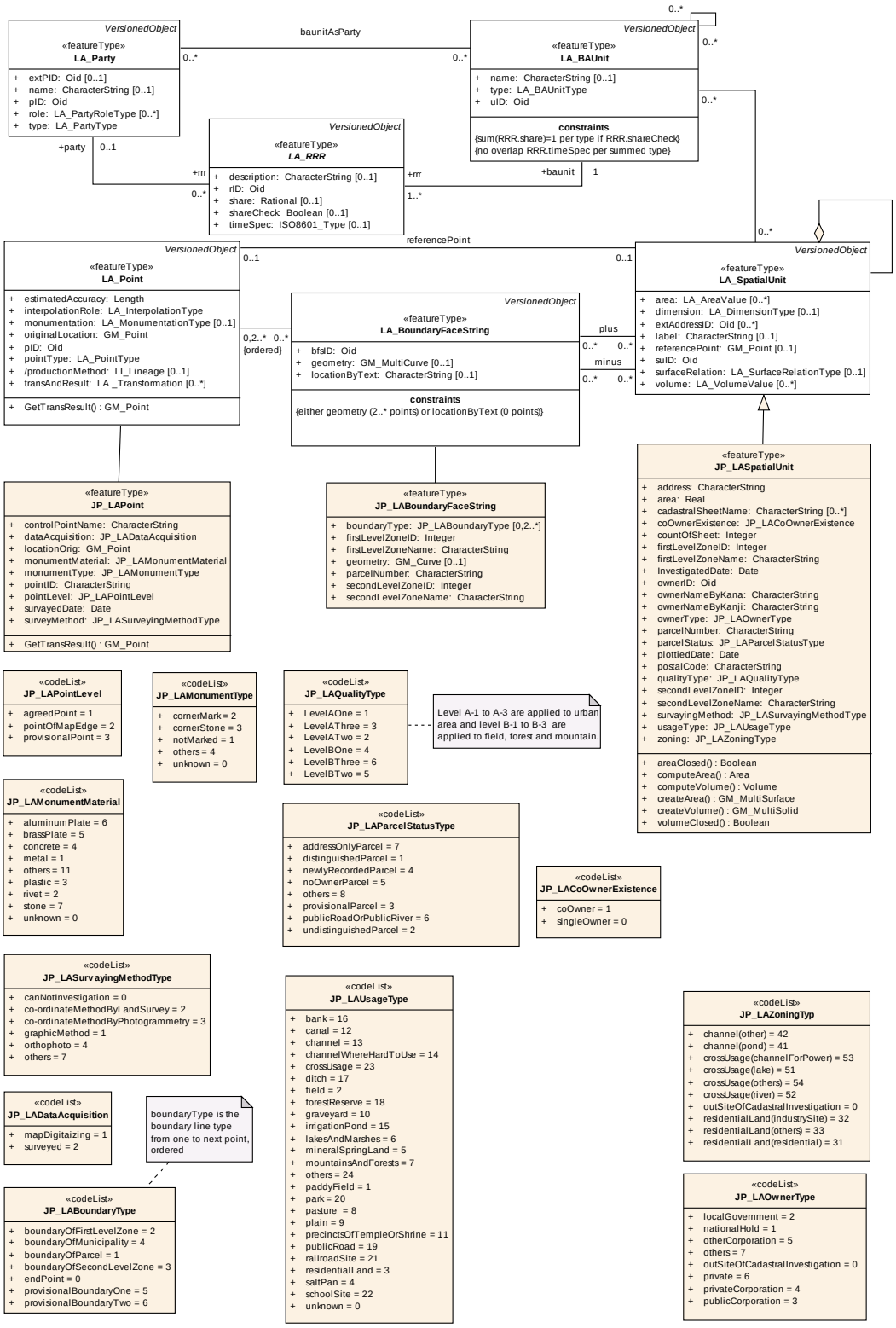


Figure D.5 — Country profile Japan

NOTE 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.

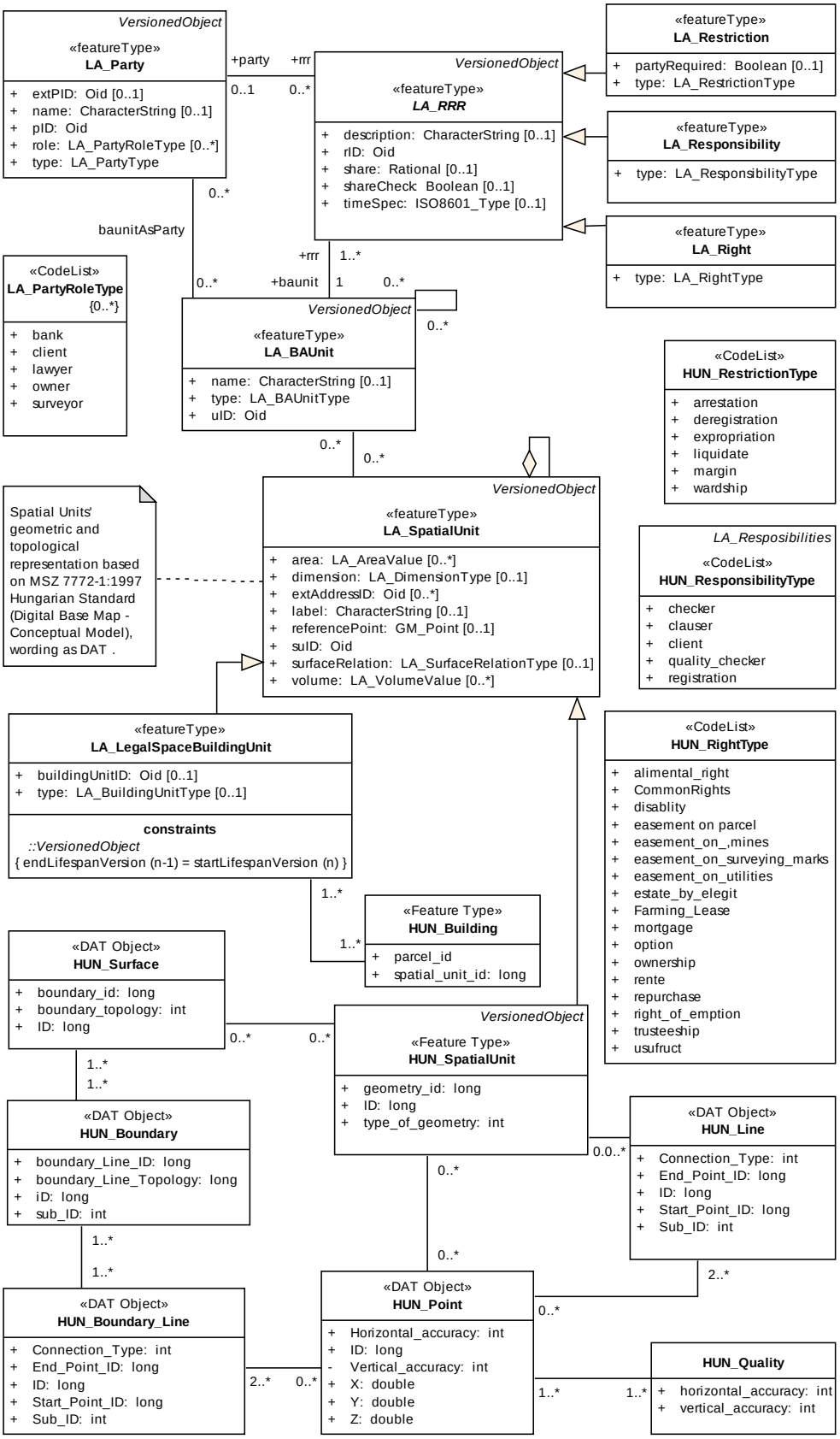


Figure D.6 — Country profile Hungary

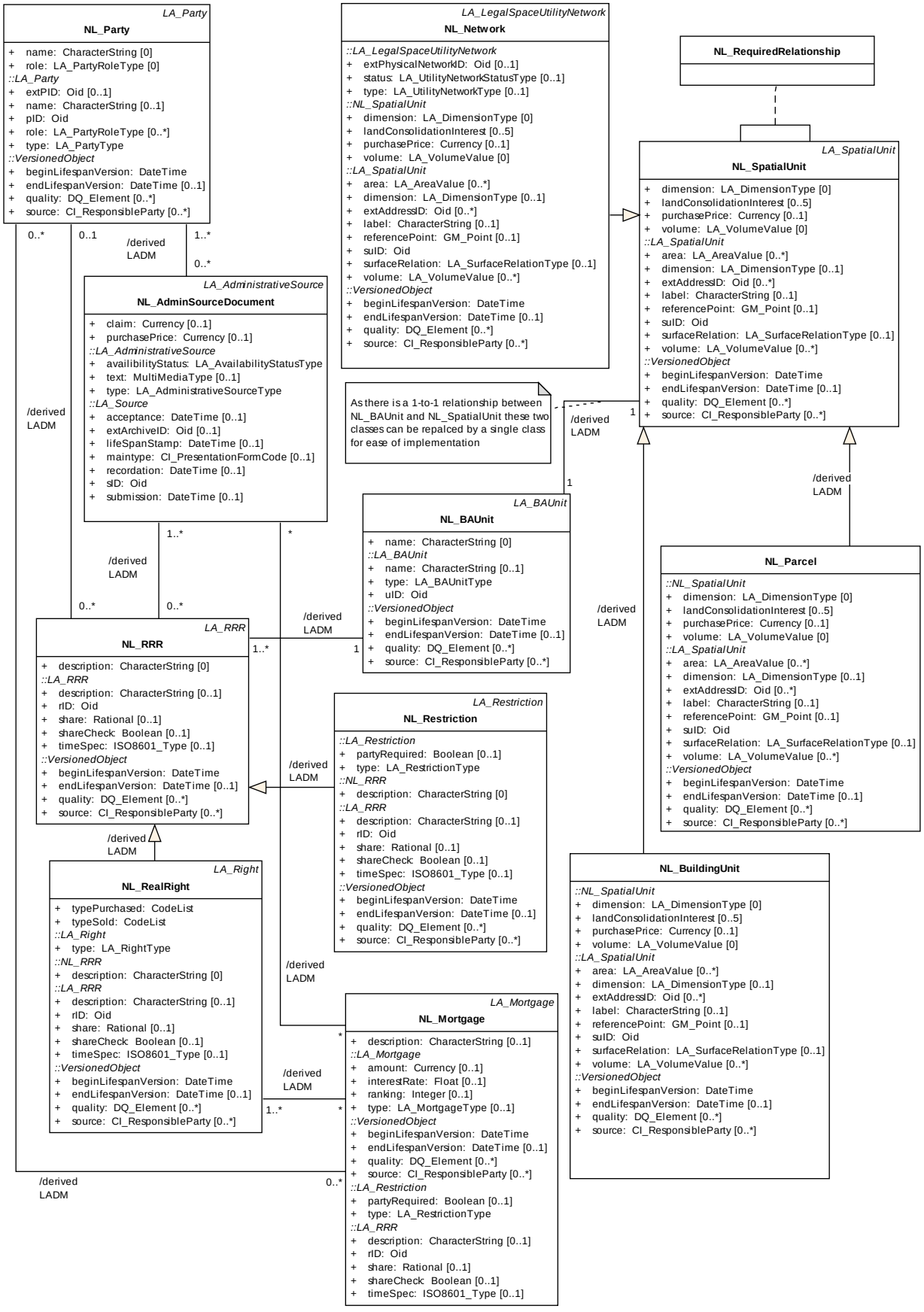


Figure D.7 — Country profile The Netherlands

Annex E
(informative)

Spatial Units and Spatial Profiles

LADM supports different types of spatial units, as indicated by the 'structure' attribute in class LA_Level:

— a 'sketch based' spatial unit is used when a sketch (a quick drawing of a group of spatial units) is available; e.g. sketch maps, and photographs, in the absence of any better identification;

— a 'point based' spatial unit (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;

— a 'text based' spatial unit (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;

— an 'unstructured (line) based' spatial unit (line spatial unit, 'spaghetti') is used when its representation is allowed to have inconsistencies, such as hanging lines and incomplete boundaries. For the 2D case, the boundary face strings are stored only once, 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);

— a 'polygon based' spatial unit (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 representation there is exactly one link to a closed boundary face string 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 representation, uses at least one (non-shared) boundary face;

— a 'topological based' spatial unit (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 representation, 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 representation, 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 by text on others. It is also possible to topologically encode text based spatial units; for example, a 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 utility networks, or for servitudes). To organize the instances, there is the concept of *level*. 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 utility

networks, crossing many other spatial units (from which the utility network space can be subtracted), see Figure E.1.

The 2D or 3D (topology) structures shall be valid at every moment in time. With topological spatial units, there are neither gaps nor 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 represented 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. 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).

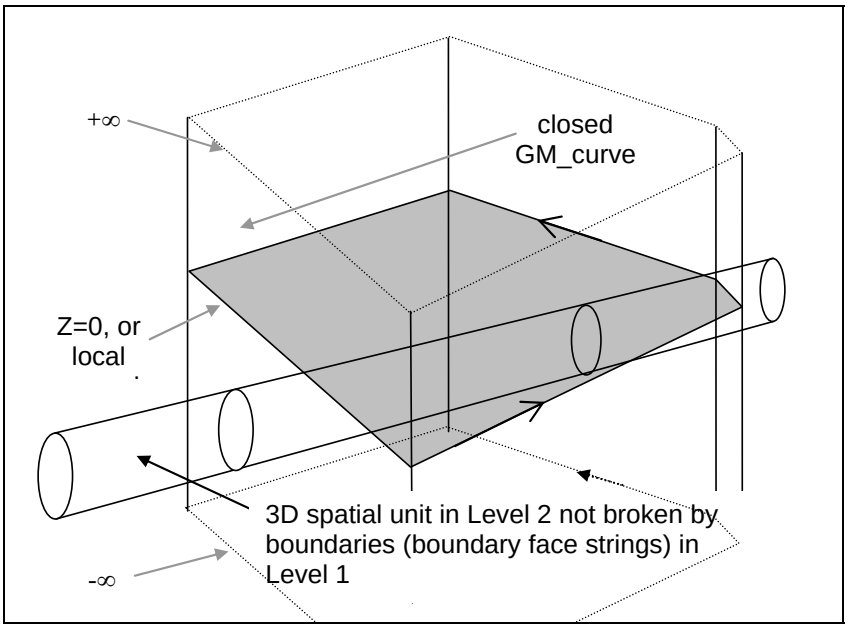


Figure E.1 — The notion of multiple levels

The Surveying and Representation subpackage of LADM (see 5.6) allows a 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, a *spatial profile*. 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 (Figure E.2)

— 2D Text based (Figure E.3)

— 2D Unstructured (line) based (Figure E.4)

— 2D Polygon based (Figure E.5)

— 2D Topological based (Figure E.6)

— 3D Topological based (Figure E.7)

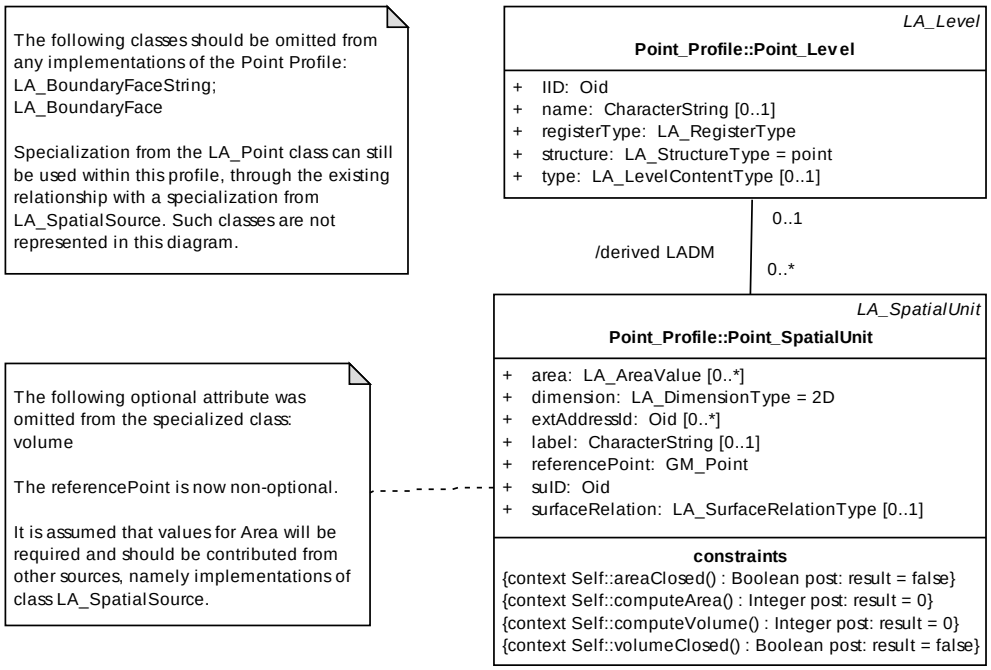


Figure E.2 — 2D Point based

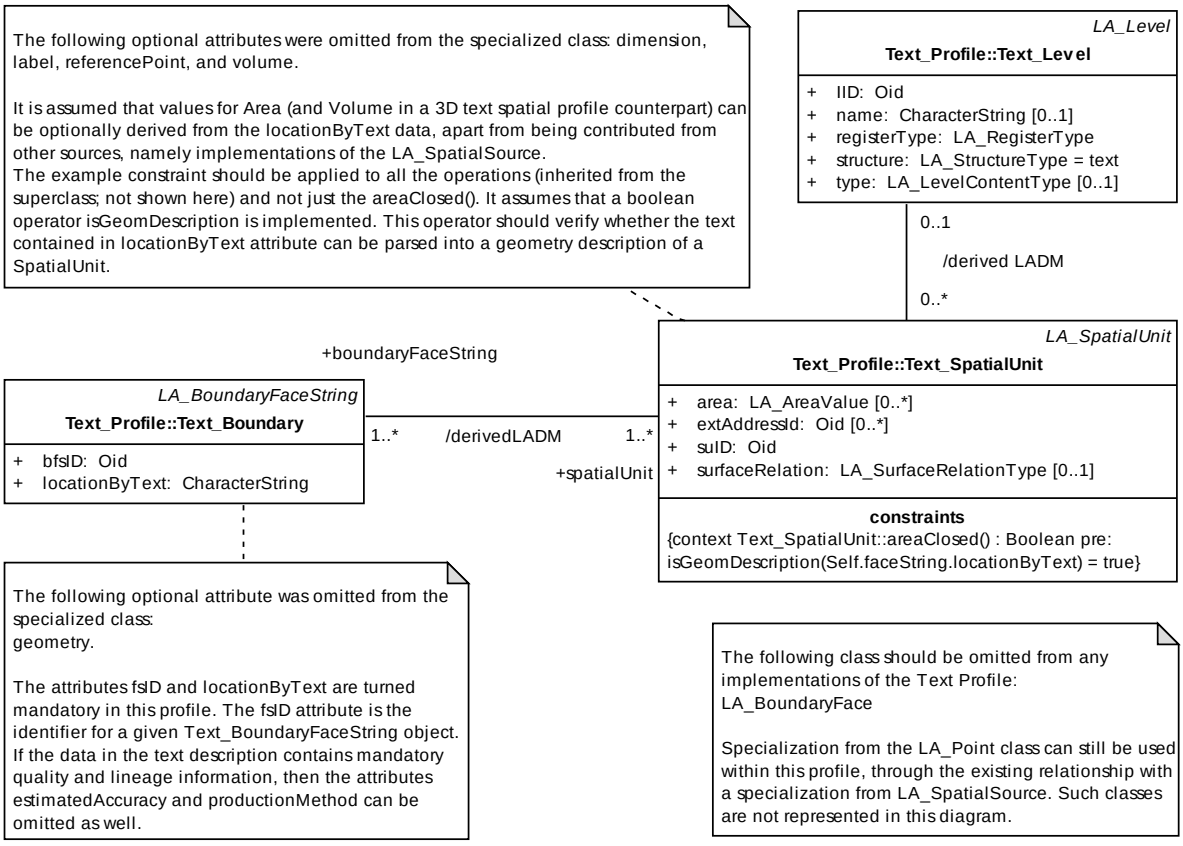


Figure E.3 — 2D Text based

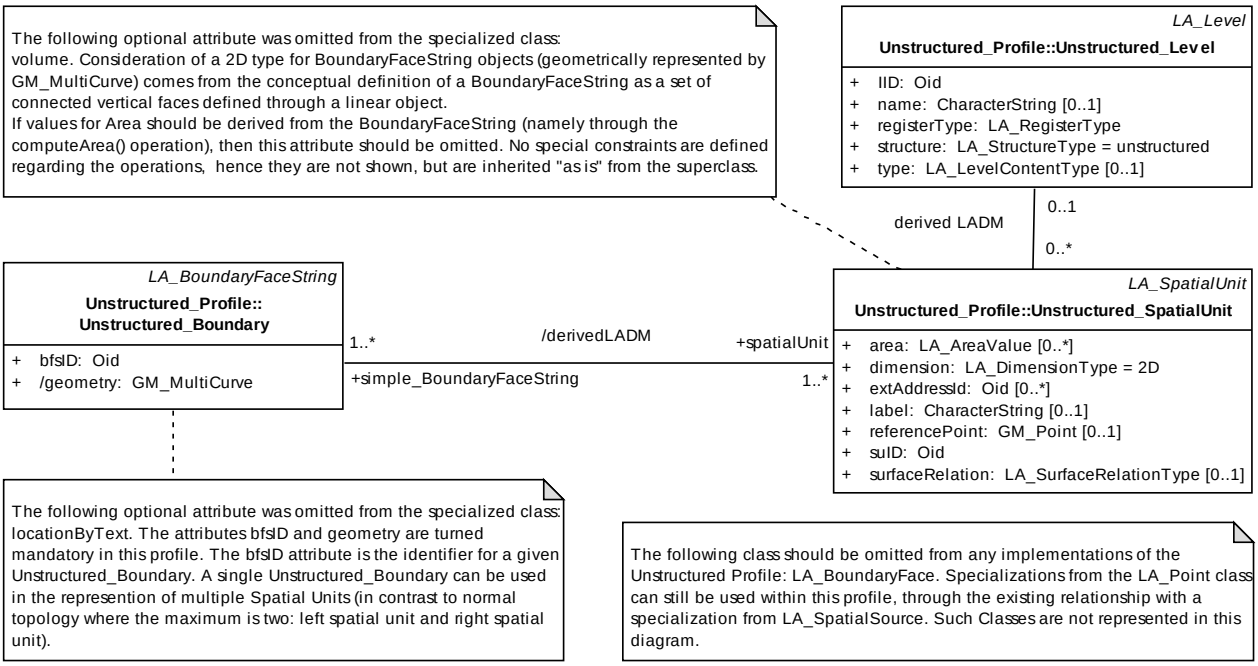


Figure E.4 — 2D Unstructured (line) based

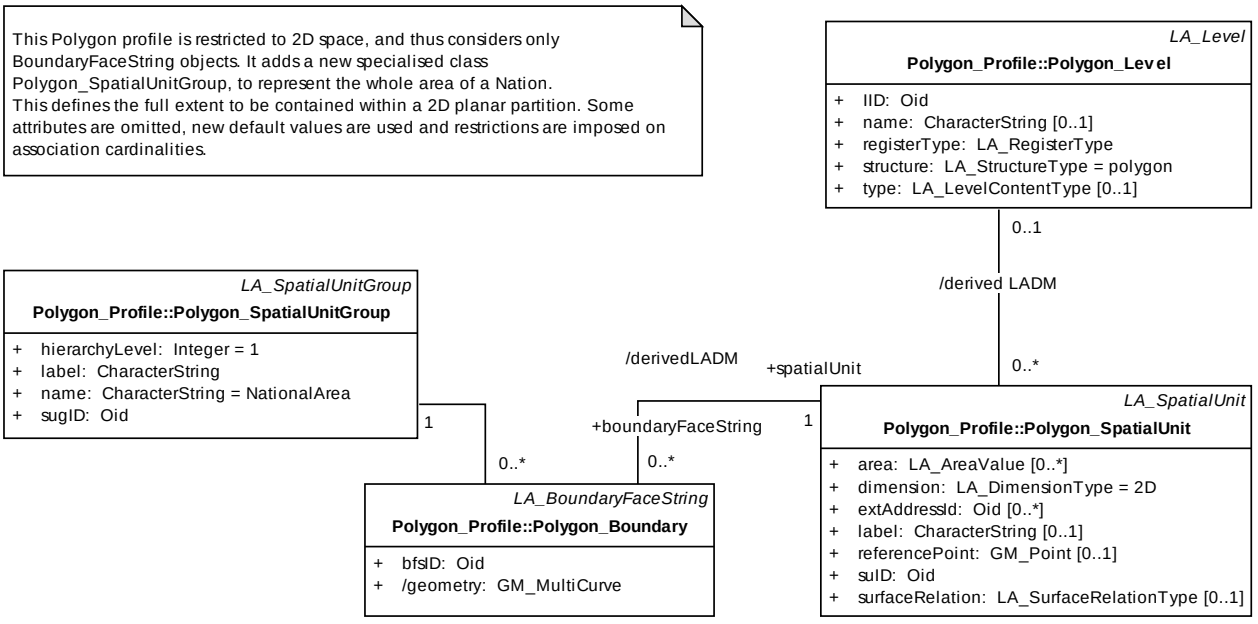


Figure E.5 — 2D Polygon based

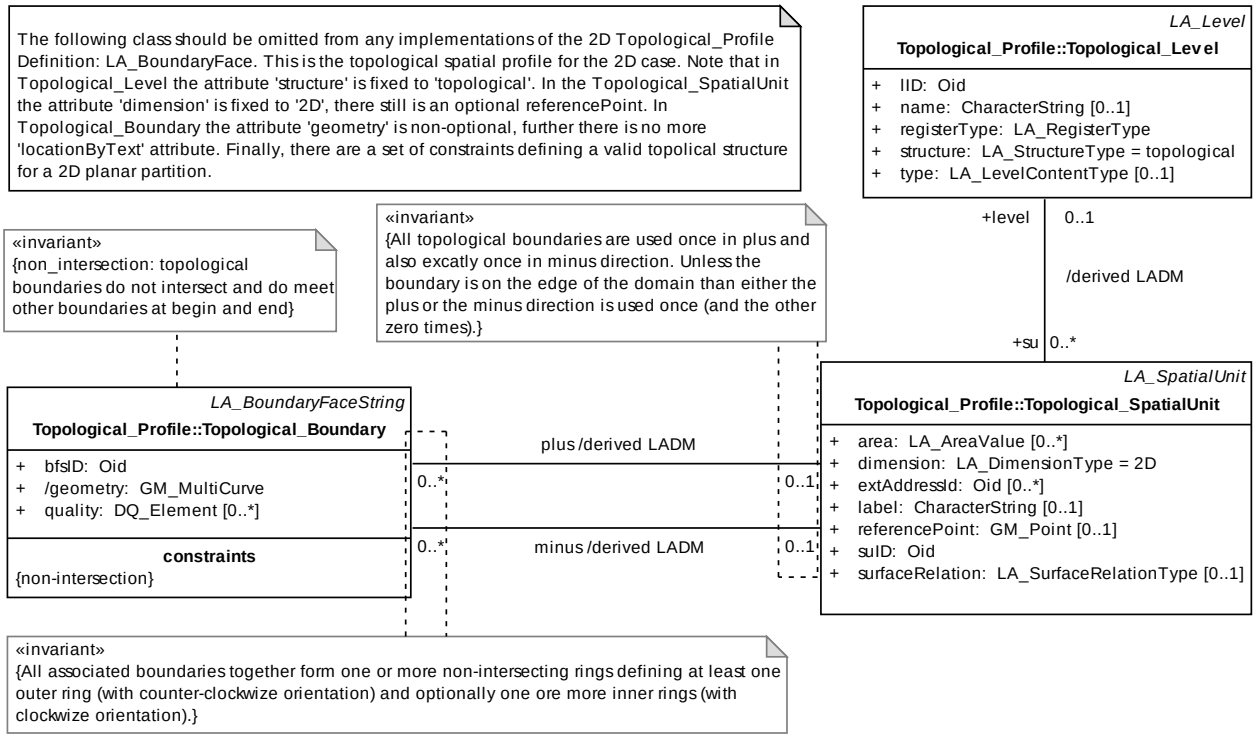


Figure E.6 — 2D Topological based

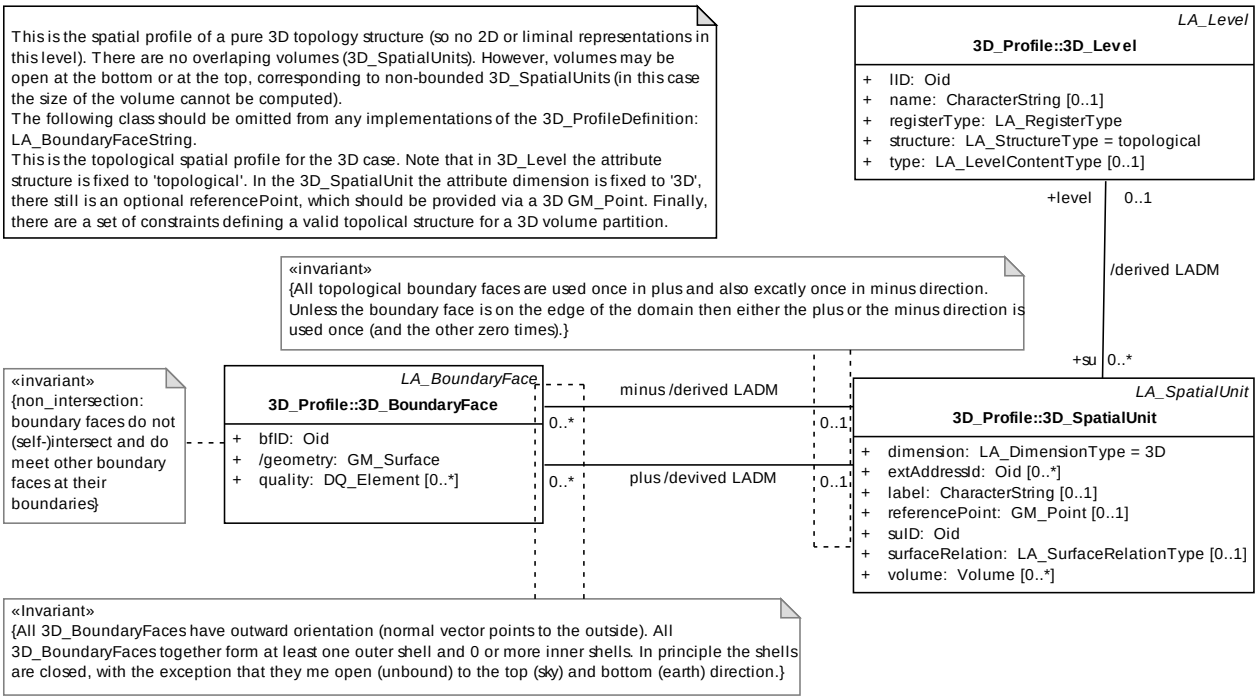


Figure E.7 — 3D Topological based

Annex F
(informative)

Legal Profiles

A *legal profile* is a profile (see 4.1.16), with elements from the Administrative Package (5.4), and from the Party Package (5.3). In this Annex three legal profiles are shown:

— a legal profile for rights (Figure F.1)

— a legal profile for restrictions (Figure F.2)

— a legal profile for responsibilities (Figure F.3).

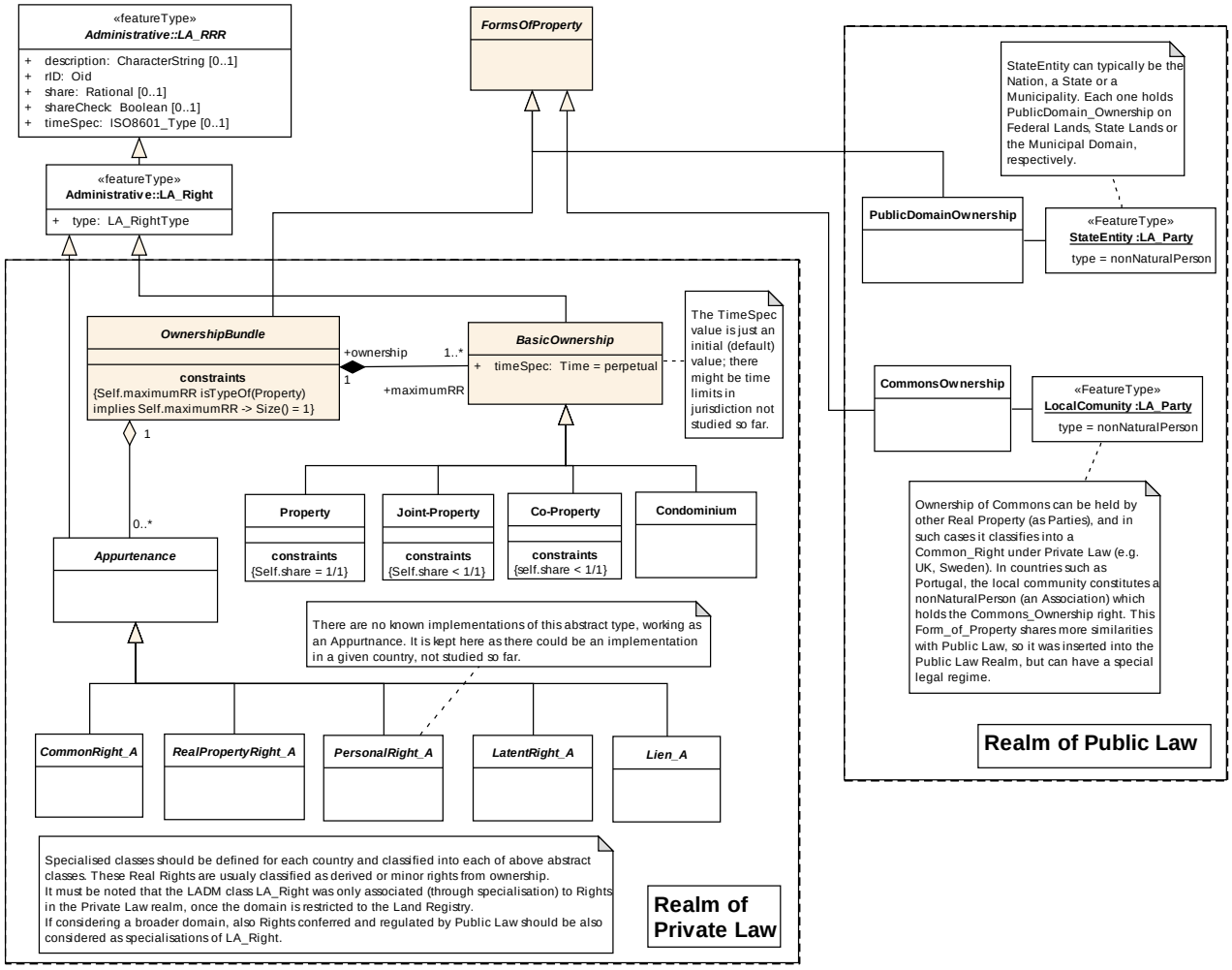


Figure F.1 — Legal profile for rights

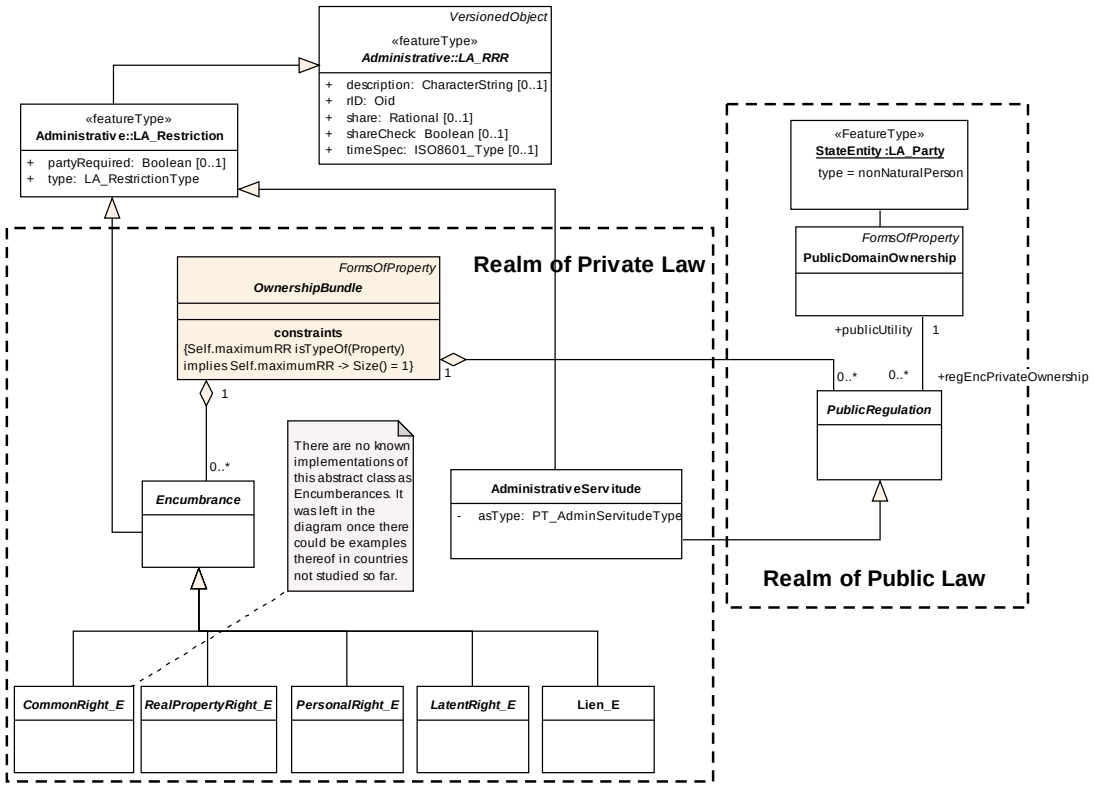


Figure F.2 — Legal profile for restrictions

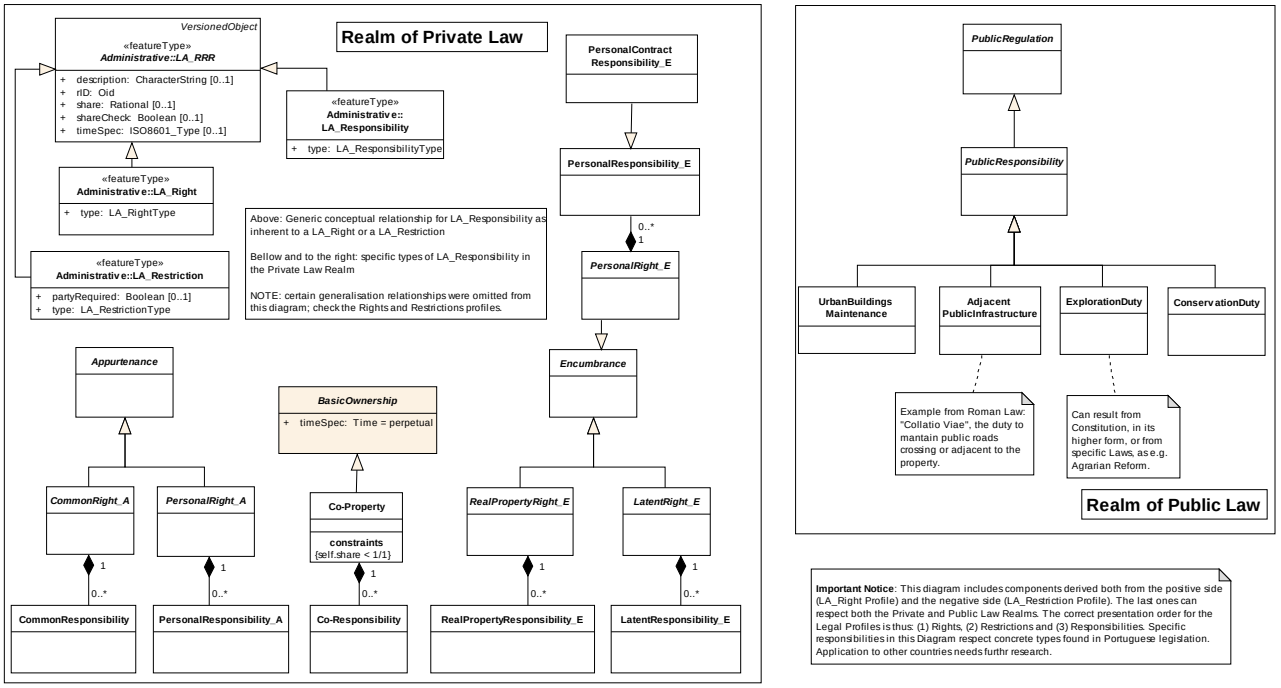


Figure F.3 — Legal profile for responsibilities

Annex G
(informative)

LADM and INSPIRE

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, ISO 19152 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 utility 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 G.1 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 G.1 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.

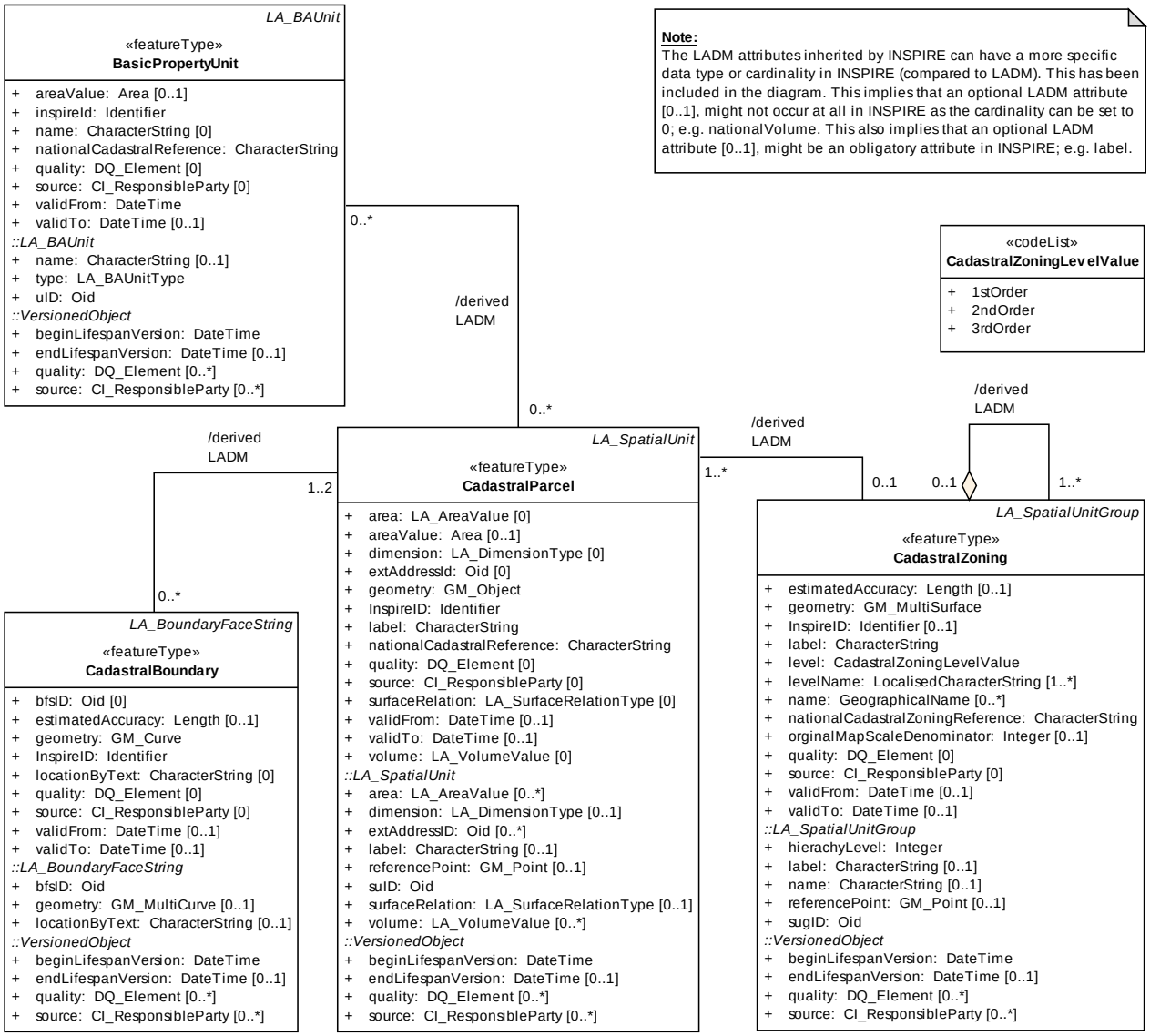


Figure G.1 — The INSPIRE cadastral parcel model based on LADM

Annex H
(informative)

LADM and LPIS

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 geospatial 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 geospatial LPIS based on Geographic Information Systems (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 time (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.

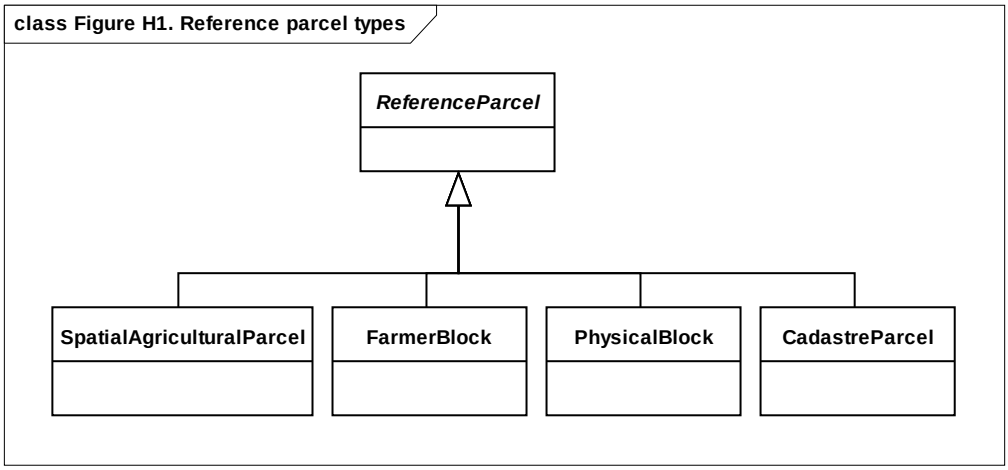


Figure H.1 — Reference parcel types

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, or conditions for eligibility for payments). 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 parcels can be either cadastral parcels or production blocks (see Figure H.1). In the end, some member states decided to build their systems as close as possible to the declared agricultural practice, and use reference units, which contain only one spatial agricultural parcel.

The main difficulties of the Cadastral parcel as reference for subsidies' application are that

i) it contains non-agricultural land, so the area eligible for payment cannot be directly determined, and

ii) that boundaries of agricultural activity are out of the scope of LA, and their maintenance via the 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 a glue between LADM and LPIS).

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

H.2.1 General

In the UML class diagrams, the current LADM classes are used, with or without small changes in their attributes, or the UML class diagrams are extended with new classes.

H.2.2 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, and test them for conformance with the EU Regulations; therefore the core model does not cover every aspect of an LPIS. Member State experts could extend the boundaries of the LCM to fit particular needs of national implementations. Figure H.2 represents the logical business model of the main concepts of the LCM. All basic concepts are represented as classes.

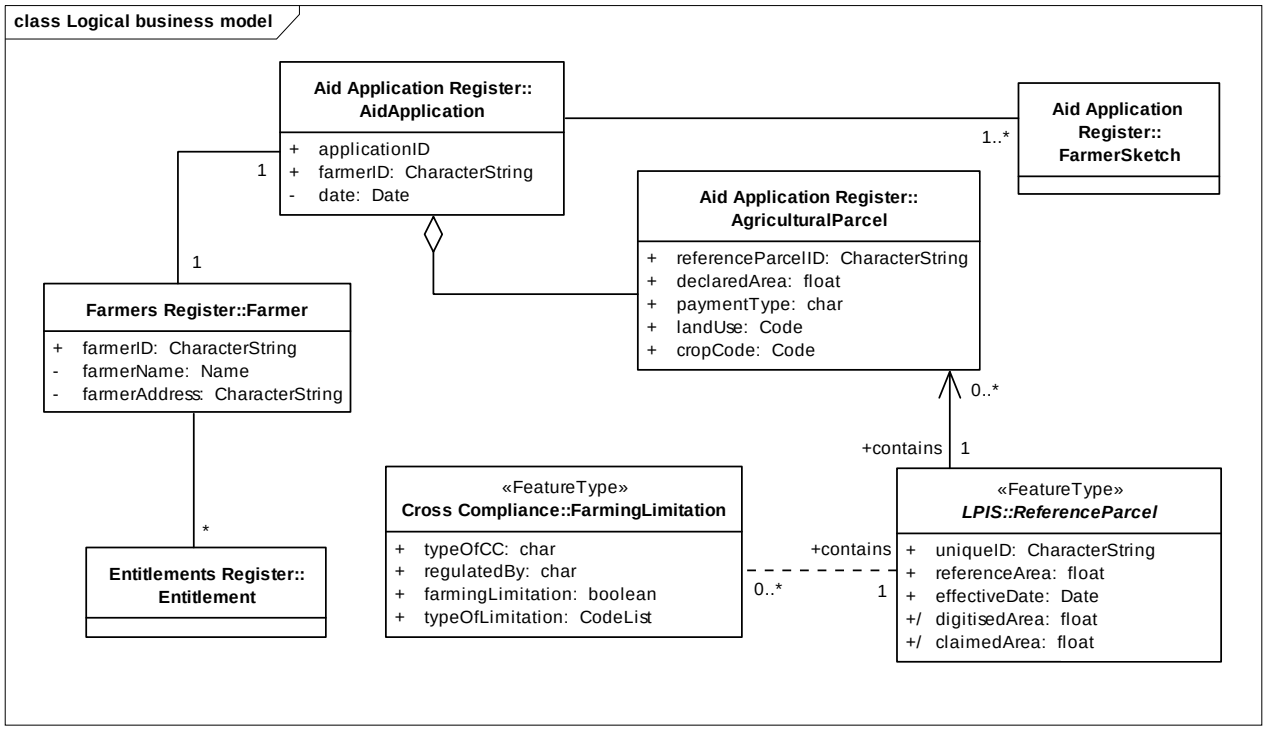


Figure H.2 — The core (classes) of the LCM

H.2.3 Integration of LCM and LADM Basic Classes

H.2.3.1 Spatial classes

The class LA_SpatialUnit is one of the basic classes of LADM. LADM also provides the functionality of administrative grouping spatial units with the class LA_BAUnit through which the legal facts (right, restrictions, responsibilities in LA_RRR) are attached. The specialized classes of LA_SpatialUnit are outside the scope of the LADM and LPIS integration (LA_LegalSpaceBuildingUnit and LA_LegalSpaceUtilityNetwork), as is the hierarchical grouping in spatial unit groups (sections, municipalities, etc.); see Figure H.3. 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_SpatialUnit. In the SubParcel class, the attribute typeSubParcel is designed to store different types of SubParcel. These are defined in the code list SubParcelType (Figure H.3). 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.

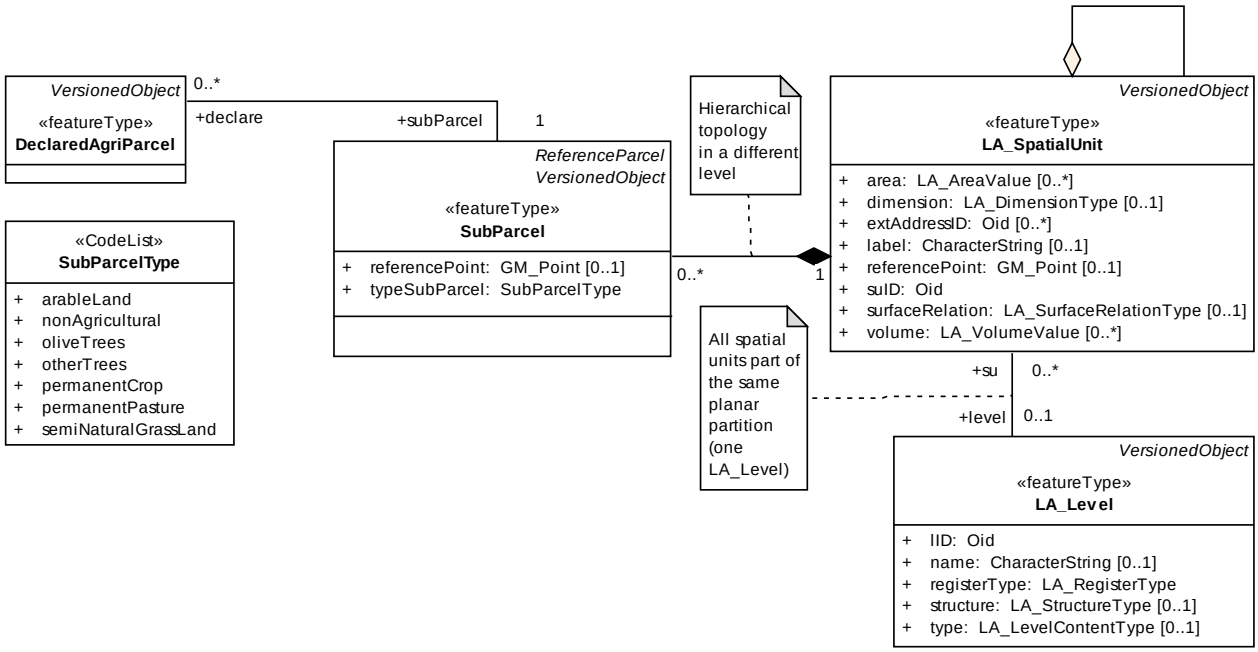


Figure H.3 — Spatial classes for LADM – IACS/LPIS collaboration

H.2.3.2 Administrative classes

LA_Party, Farmer, Right/Restriction/Responsibility (LA_RRR), YearlyAidApplication, YearlyFarmerSketch, DeclaredAgriParcel are the basic classes designed to manage administrative data in the model (Figure H.4). LA_Party and LA_RRR are two basic classes coming from LADM. Other classes are designed for the description of LPIS administrative data.

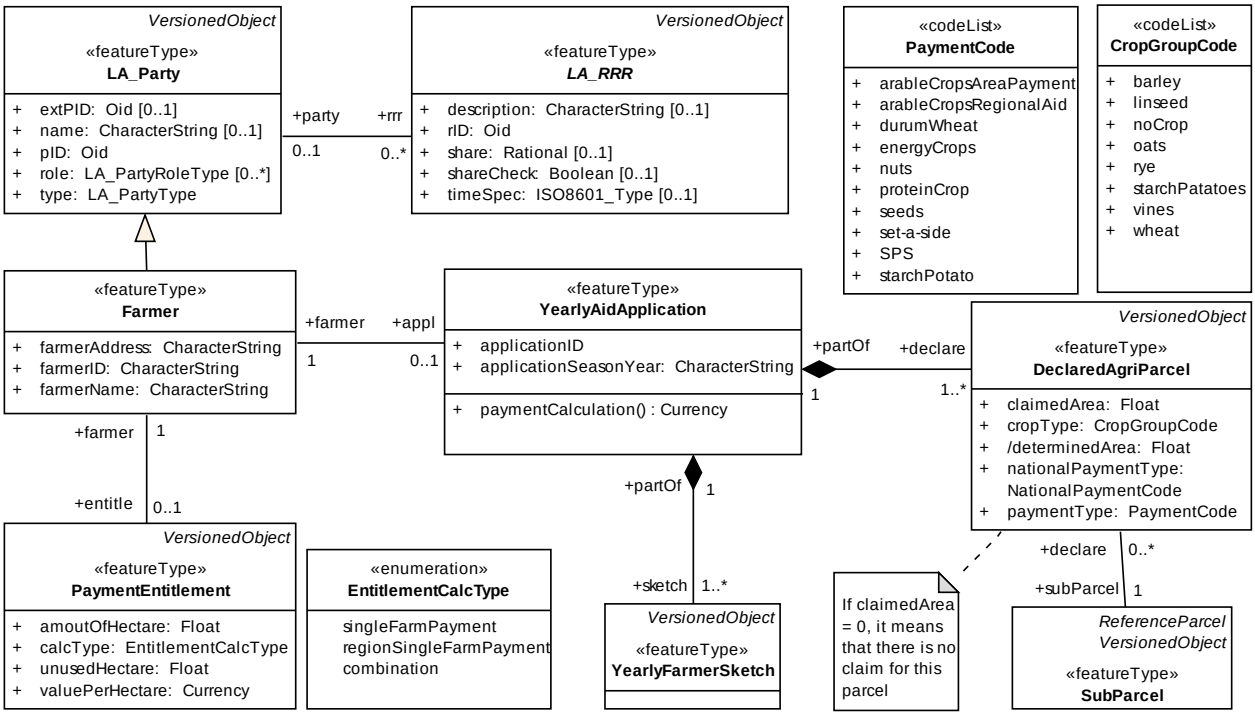


Figure H.4 — Administrative classes for LADM – LPIS integration

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 (DeclaredAgriParcel and YearlyFarmerSketch) composing the YearlyAidApplication (a 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 the 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 cannot be without any aid application.

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

A *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 class designed for LADM. In Figure H.5, LA_Party is the main class, which represents natural persons and non-natural persons, 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. One is farmerID, which indicates that the person is a farmer. Another is farmerAddress, which includes up-to-date address information.

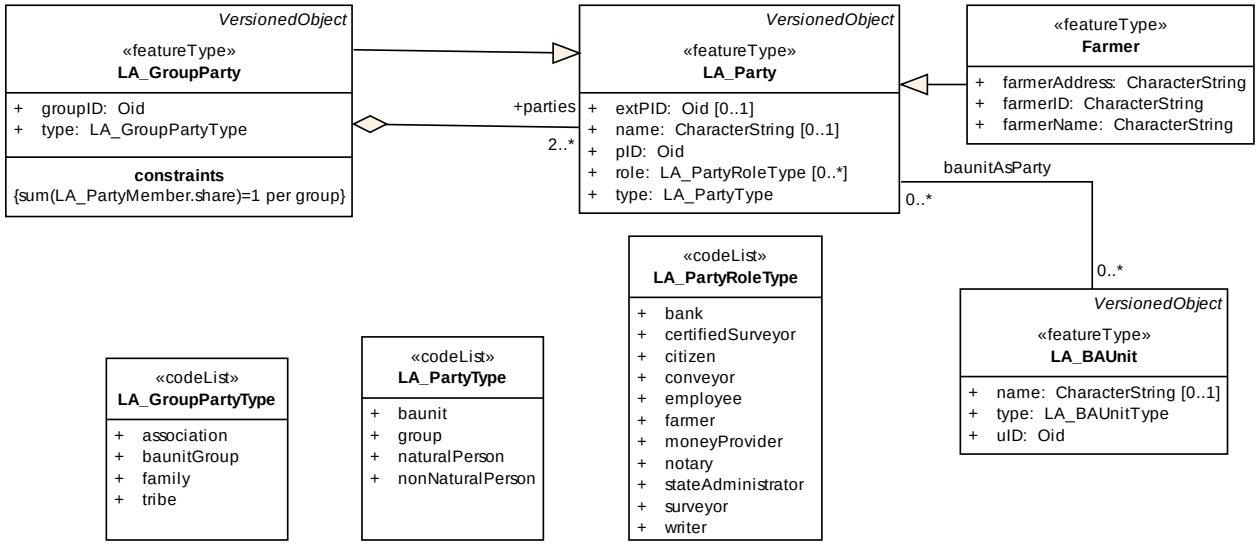


Figure H.5 — Person classes: LA_Party, LA_GroupParty and Farmer

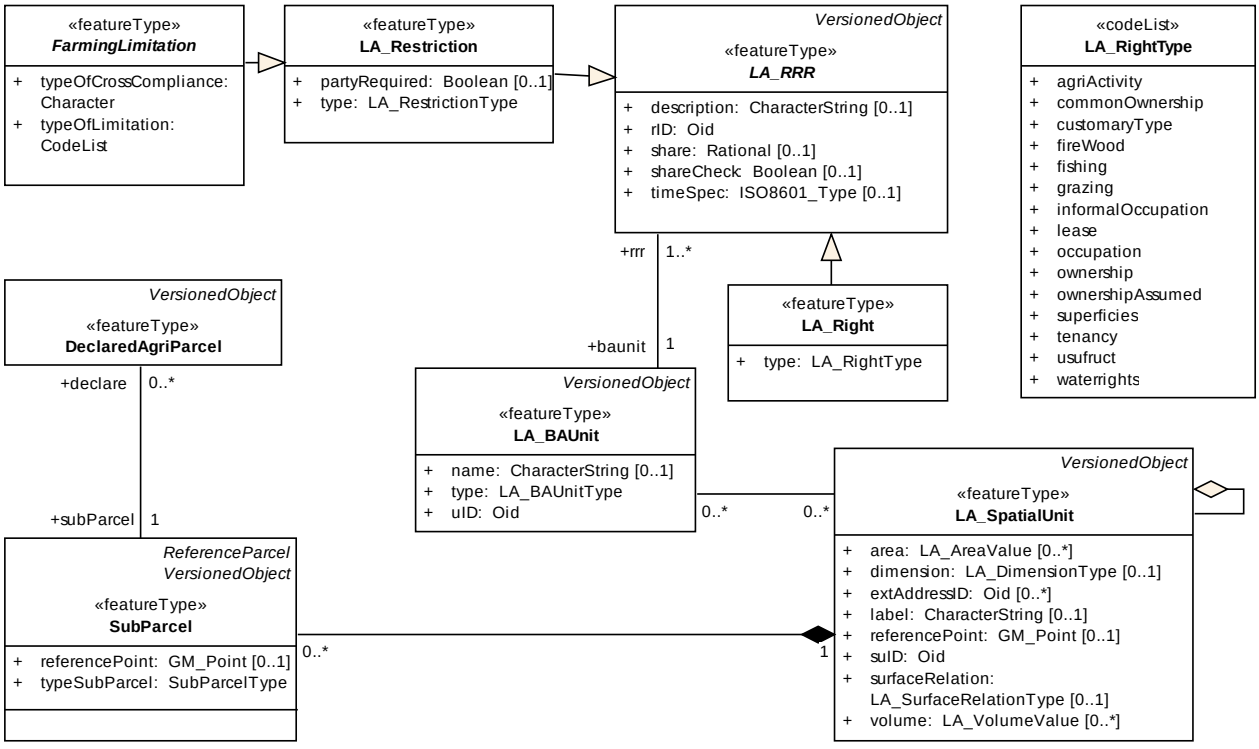


Figure H.6 — Associations of rights and restrictions to DeclaredAgriParcel class

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 H.6). The only right IACS/LIPS is about is the right to be paid (entitlement). It is associated with Farmer and via YearlyAidApplication and DeclaredAgriParcel to SubParcel. It is not related directly to LA_SpatialUnit.

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 LA system/Cadastre deals with owners and they may not be the same person. Unlike such kind of common understanding, LA systems, 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 an LA system a multi-purpose cadastre. However, it is a fact that conventional LA systems as legacy systems are currently not always capable of administering all kinds of land related rights. This is why LA systems are generally underestimated by third parties. Therefore, registration of farmers and farming rights in an LA system 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.

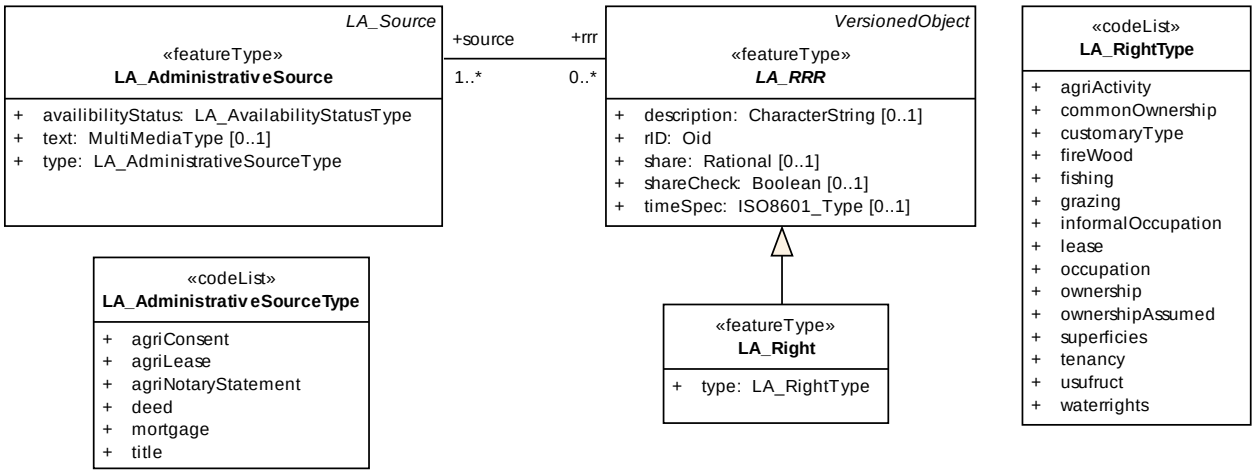


Figure H.7 — Registration of farming rights with LADM classes

In this example, farming rights are designed as part of an LA system with a few extensions in code lists (LA_RightType and LA_AdministrativeSourceType) with attribute values for attributes of some LADM classes (see Figure H.7). The idea is that this will enable the application of an integrated solution for the management of land use rights both for LA system and LPIS applications.

In order to try to design and test properly the model presented above, the modelling 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
(informative)

STDM

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).

Table I.1 — LADM class names with their aliases in STDM

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

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 I.1).

EXAMPLE 1 Collaterals are demonstrated in instance diagrams, see Figure C.27 (Annex C).

EXAMPLE 2 Parcels are demonstrated in instance diagrams, see Figure C.2 (Annex C).

EXAMPLE 3 STDM relationships are demonstrated in instance diagrams, see Figures C.2, C.12, C.13, C.14 and C.27 (Annex C).

Annex J
(informative)

Code lists

Code lists are used to describe a more open and flexible enumeration. Code lists are useful for expressing a long list of potential values. The code lists included in LADM aim to allow the use of local, regional or national terminology. Figures J.1, J.2, J.3 and J.4 show possible examples of values for these code lists.

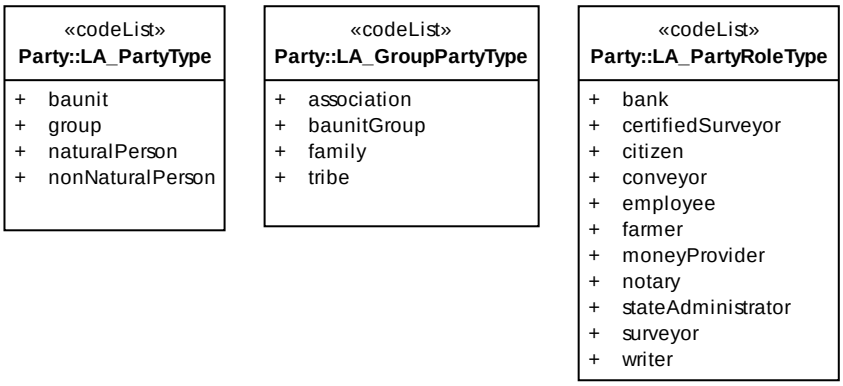


Figure J.1 — Code lists for Party Package

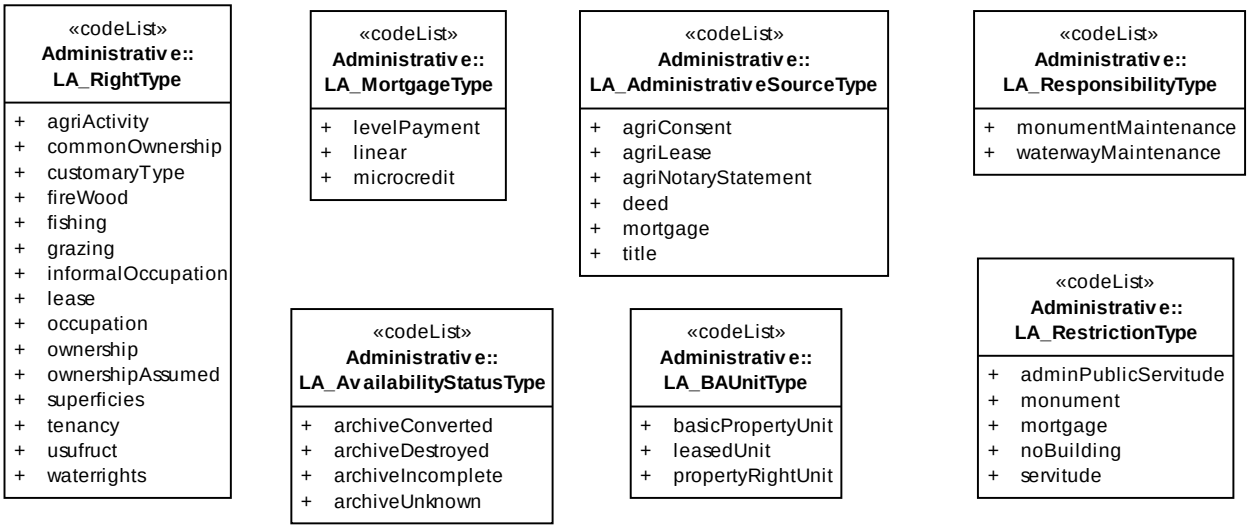


Figure J.2 —Code lists for Administrative Package

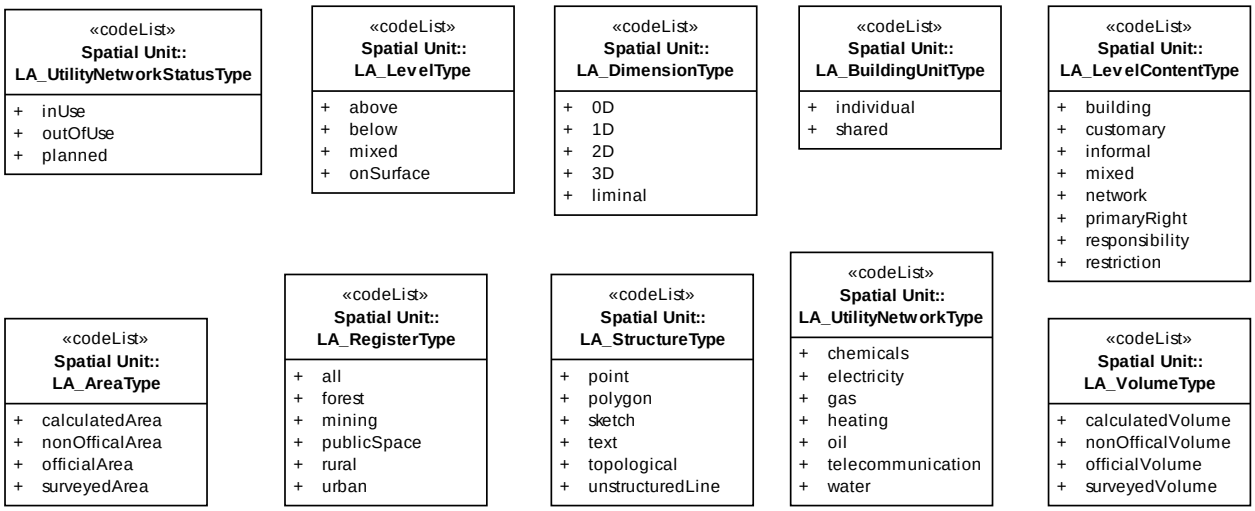


Figure J.3 — Code lists for Spatial Unit Package

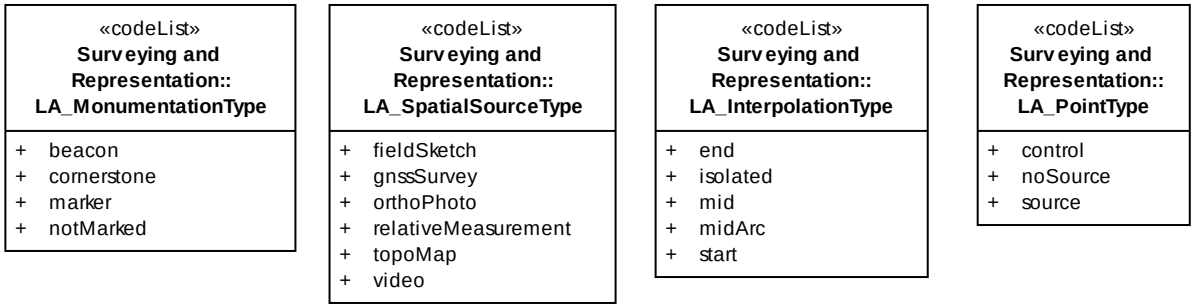


Figure J.4 — Code lists for Surveying and Representation Subpackage

Annex K
(informative)

External Classes

K.1 Introduction

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

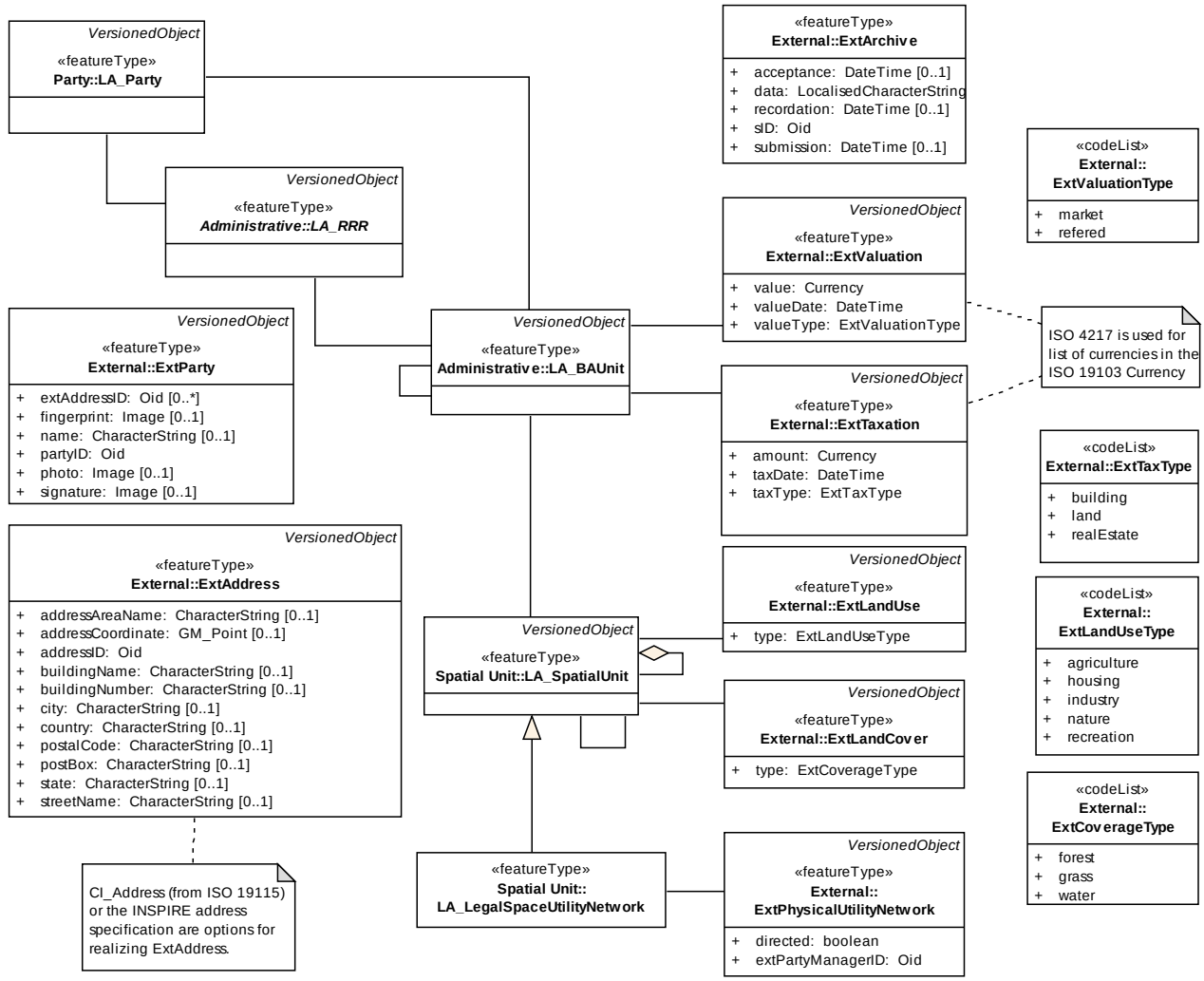


Figure K.1 — External LADM classes

K.2 ExtParty

Class ExtParty is a class for an external registration of parties, see Figure K.1.

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.

K.3 ExtAddress

Class ExtAddress is a class for an external registration of addresses (an address being a direction for finding some location), see Figure K.1.

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.

K.4 ExtTaxation

Class ExtTaxation is a class for the external registration of taxation data. ExtTaxation is associated to class LA_BAUnit, see Figure K.1.

The attributes of ExtTaxation are:

— amount: the amount of taxation;

— taxDate: the date of taxation;

— taxType: the tax type.

EXAMPLE Taxation data are demonstrated in instance diagrams, see Figure C.18 (Annex C).

K.5 ExtLandUse

Class ExtLandUse is a 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. ExtLandUse is associated to class LA_SpatialUnit, see Figure K.1.

The attribute of ExtLandUse is:

— type: the type of land use.

K.6 ExtLandCover

Class ExtLandCover is a class for the external registration of land cover data; land cover is the observed (bio)physical cover on the earth's surface. ExtLandCover is associated to class LA_SpatialUnit, see Figure K1.

The attribute of ExtLandCover is:

— type: the type of land cover.

K.7 ExtValuation

Class ExtValuation is a class for the external registration of valuation data. ExtValuation is associated to class LA_BAUnit, see Figure K1.

The attributes of ExtValuation are:

— value: the value of the valuation:

— valueDate: the date of the valuation;

— valueType: the valuation type.

EXAMPLE Valuation data are demonstrated in instance diagrams, see Figure C.18 (Annex C).

K.8 ExtPhysicalUtilityNetwork

Class ExtPhysicalUtilityNetwork is a class for the external registration of mapping data of utility networks. ExtPhysicalUtilityNetwork is associated to class LA_LegalSpaceUtilityNetwork, see Figure K.1.

The attributes of ExtPhysicalUtilityNetwork are:

— directed: the flow direction, fixed or not;

— managerID: the organization responsible for the utility network.

K.9 ExtArchive

Class ExtArchive is a class for the external registration of sources, see Figure K.1.

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.

K.10 Code Lists for External Classes

Figure K.2 shows code lists for external classes.

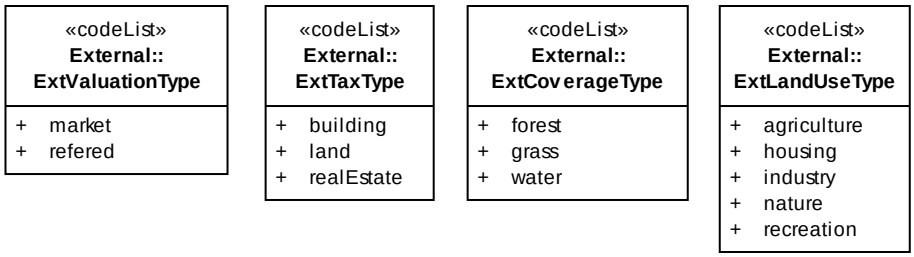


Figure K.2 — LADM code lists for external classes

Annex L
(informative)

Interface Classes

Interface classes can be 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 L.1), spatial units (see Figure L.2), and maps with spatial units – e.g. cadastral maps (see Figure L.3).

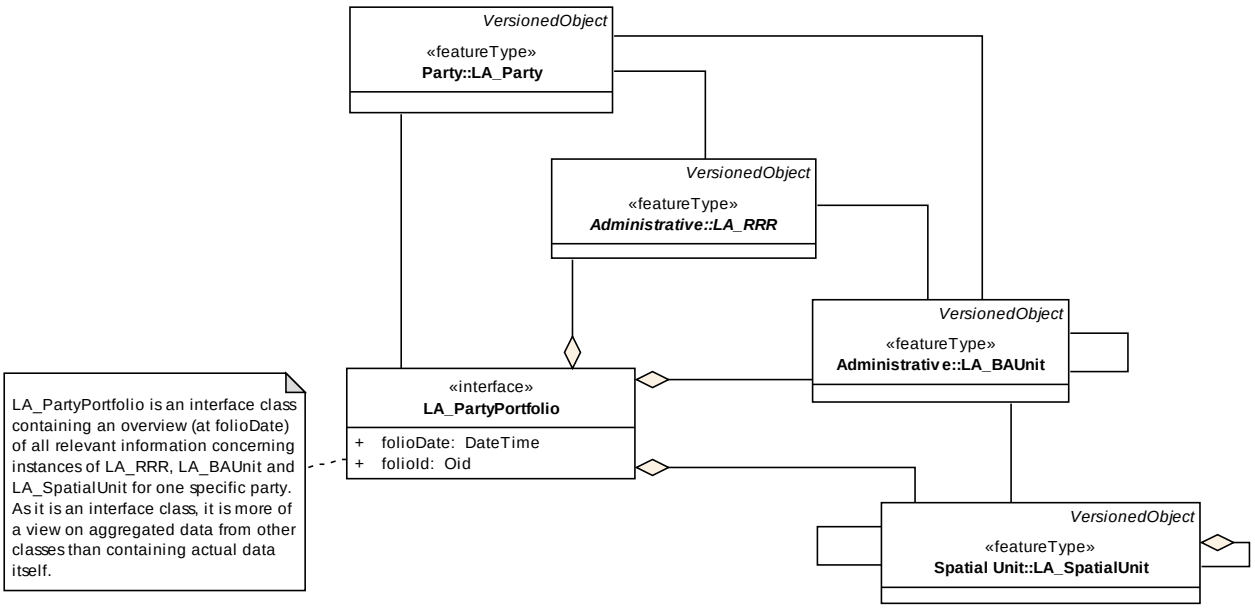


Figure L.1 — Interface class for parties

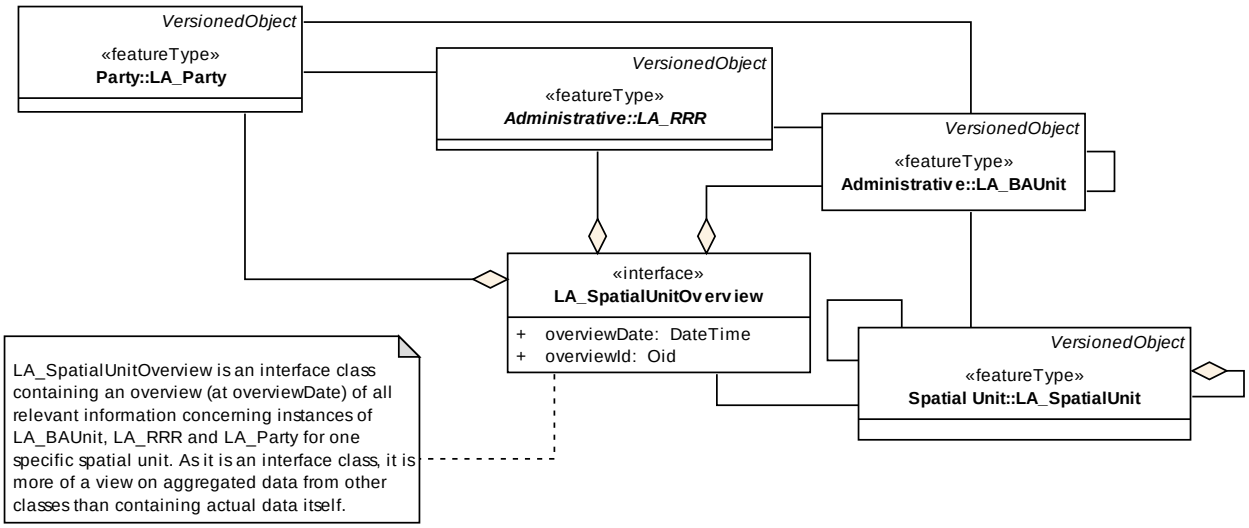


Figure L.2 — Interface class for spatial units

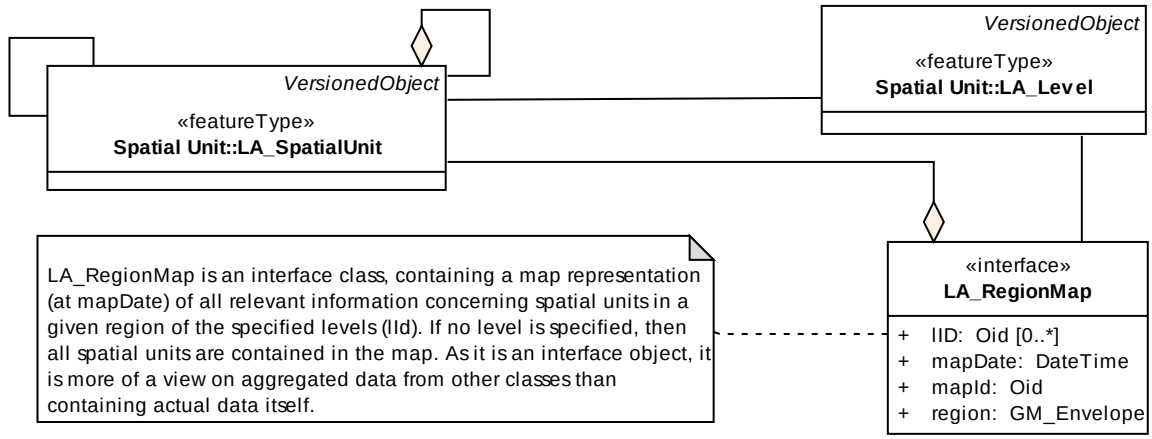


Figure L.3 — Interface class for mapping spatial units

Annex M
(informative)

Modelling Land Administration Processes

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 diagrams, sequence diagrams, collaboration diagrams, state diagrams, 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 a spatial unit (point, image, surveyed), of a right (start, landhold, freehold), or of a party, further reflect the dynamic nature of the system.

Annex N
(informative)

History and Dynamic Aspects

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 support 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 class 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.

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