INTERNATIONAL STANDARD

ISO 19152

First edition
2012-12-01

Geographic information — Land Administration Domain Model (LADM)

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

Reference number
ISO 19152:2012(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

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

Introduction

This International Standard defines the Land Administration Domain Model (LADM). The LADM is a conceptual model, and not a data product specification (in the sense of ISO 19131).

The purpose of the LADM is not to replace existing systems, but rather to provide a formal language for describing them, so that their similarities and differences can be better understood. This is a descriptive standard, not a prescriptive standard.

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. The LADM provides a reference model which will serve two goals:

— to provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on 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 that:

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

— it will be based on the conceptual framework of ‘Cadastre 2014’ of the International Federation of Surveyors (FIG) [14];

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

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

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 will 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 can 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 (the Internet, geospatial databases, 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, generally referred to as spatial units) and persons (e.g. citizens, legally referred to as subjects and generally referred to as 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.

The scope of this International Standard is provided in Clause 1. Conformance in relation to this International Standard is given in Clause 2, and a conformance test is specified in Annex A. Normative references are presented in Clause 3 and the used terms, definitions and abbreviations in Clause 4. Clause 5 gives a global overview of packages. Clause 6 introduces the classes, attributes and associations in detail. Annex B explains the 2D and 3D representations of spatial units. A comprehensive set of informative examples (using instance level classes) is available in Annex C.

It must be noted that this is a generic domain model. It is expandable and it is likely that additional attributes, operators, associations, and perhaps even additional classes, will be needed for a specific region or country; see the country profiles in Annex D. Specific parts of the LADM are further detailed: the spatial profiles in Annex E and the legal profiles in Annex F. Some examples of using the LADM in a specific context are: the INSPIRE cadastral parcels in Annex G, the integration of the LADM with the agricultural Land Parcel Identification Systems (LPIS) of the European Union in Annex H, and the Social Tenure Domain Model (STDM) in Annex I. It is possible to use only a subset, or profile, of the LADM for a specific implementation.

Annex J gives an overview of code tables as a basis to describe a flexible enumeration.

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 the LADM. However, the LADM provides stereotype classes for these data sets (if available), see Annex K. Interface classes are in Annex L. Annex M makes some remarks in relation to process models. History and dynamic aspects are included in Annex N. Annex O explains the link to other ISO international standards.

Geographic information — Land Administration Domain Model (LADM)

1 Scope

This International Standard:

— defines a reference Land Administration Domain Model (LADM) covering basic information-related components of land administration (including those over water and land, and elements above and below the surface of the earth);

— provides an abstract, conceptual model with four packages related to

1) parties (people and organizations);

2) basic administrative units, rights, responsibilities, and restrictions (ownership rights);

3) spatial units (parcels, and the legal space of buildings and utility networks);

4) spatial sources (surveying), and spatial representations (geometry and topology);

— provides 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, the LADM provides stereotype classes for these data sets to indicate which data set elements the LADM expects from these external sources, if available; and

— modelling of land administration processes.

2 Conformance

The LADM consists of three packages and one subpackage, and for each of them a conformance test is specified in Annex A. Three conformance levels are specified per (sub)package: level 1 (low level), level 2 (medium level), and level 3 (high level). Level 1 tests the basic classes per package and level 2 also includes the more common classes. Level 3 includes all classes. Any LADM claiming conformance to this International Standard shall satisfy the requirements of Annex A.

3 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4217:2008, *Codes for the representation of currencies and funds*

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

ISO/IEC 13240:2001, *Information technology — Document description and processing languages — Interchange Standard for Multimedia Interactive Documents (ISMID)*

ISO 14825:2011, *Intelligent transport systems — Geographic Data Files (GDF) — GDF5.0*

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

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

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 19156:2011, *Geographic information — Observations and measurements*

4 Terms, definitions, and abbreviations

4.1 Terms and definitions

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

4.1.1
administrative source
source (4.1.21) with the administrative description (where applicable) of the **parties** (4.1.13) involved, the **rights** (4.1.20), **restrictions** (4.1.19) and **responsibilities** (4.1.18) created and the **basic administrative units** (4.1.2) affected

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

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

4.1.2
basic administrative unit
baunit
administrative entity, subject to registration (by law), or recordation [by informal **right** (4.1.20), or customary right, or another social tenure relationship], consisting of zero or more **spatial units** (4.1.23) against which (one or more) unique and homogeneous rights [e.g. ownership right or **land** (4.1.9) use right], **responsibilities** (4.1.18) or **restrictions** (4.1.19) are associated to the whole entity, as included in a **land administration** (4.1.10) system

NOTE 1 'Unique' means that a right, restriction, or responsibility is held by one or more **parties** (4.1.13) (e.g. owners or users) for the whole basic administrative unit. 'Homogeneous' means that a right, restriction or responsibility (e.g. ownership, use, social tenure, lease, or easement) affects the whole basic administrative unit. For a restriction, zero parties are a possibility.

NOTE 2 A basic administrative unit may play the role of party, e.g. when the right holder is a basic administrative unit (and not a person or organization).

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

NOTE 4 A baunit can consist of zero spatial units, when a registry exists, and not a cadastre.

NOTE 5 Restrictions and responsibilities can be associated with their own baunits, each with their own type of spatial unit.

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

4.1.3
boundary
set that represents the limit of an entity

[ISO 19107:2003, 4.4]

NOTE Boundary is most commonly used in the context of geometry, where the set is a collection of points or a collection of objects that represent those points. In other arenas, the term is used metaphorically to describe the transition between an entity and the rest of its domain of discourse.

4.1.4
boundary face
face (4.1.7) that is used in the 3-dimensional representation of a **boundary** (4.1.3) of a **spatial unit** (4.1.23)

NOTE Boundary faces are used when the implied vertical and unbounded faces of a **boundary face string** (4.1.5) 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 (4.1.3) forming part of the outside of a **spatial unit** (4.1.23)

NOTE Boundary face strings are used to represent the boundaries of spatial units by means of line strings in 2D. This 2D representation is a 2D boundary in a 2D **land administration** (4.1.10) system. In a 3D land administration system it represents a series of vertical **boundary faces** (4.1.4) where 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 may be used for different purposes (e.g. living or commercial) or it can be under construction.

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

4.1.7
face
2-dimensional topological primitive

[ISO 19107:2003, 4.38]

NOTE The geometric realization of a face is a surface. The boundary of a face is the set of directed edges within the same topological complex that are associated to the face via the boundary relations. These can be organized as rings.

4.1.8
group party
any number of **parties** (4.1.13), together forming a distinct entity, with each party registered

NOTE A group party may be a **party member** (4.1.14) 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]

4.1.10
land administration
process of determining, recording and disseminating information about the relationship between people and **land** (4.1.9)

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** (4.1.23), with a geometric, and/or topological, and/or thematic coherence

EXAMPLE 1 One level of spatial units for an urban cadastre and another for spatial units for a rural cadastre.

EXAMPLE 2 One level of spatial units to define **basic administrative units** (4.1.2) associated with **rights** (4.1.20) and another level of spatial units to define basic administrative units associated with **restrictions** (4.1.19).

EXAMPLE 3 One level of spatial units to define basic administrative units associated with formal rights, a second level for spatial units to define basic administrative units associated with informal rights and a third level for spatial units to define basic administrative units associated with customary rights.

EXAMPLE 4 One level with **point** (4.1.15) 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 (4.1.23) on the threshold between 2D and 3D representations

4.1.13
party
person or organization that plays a role in a **rights** (4.1.20) transaction

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** (4.1.2) may be a party because it may hold a right of e.g. easement.

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

4.1.14
party member
party (4.1.13) registered and identified as a constituent of a **group party** (4.1.8)

4.1.15
point
0-dimensional geometric primitive, representing a position

[ISO 19107:2003, 4.61]

NOTE 1 A point may be used to define one or more **boundary faces** (4.1.4) or **boundary face strings** (4.1.5).

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, 4.5]

NOTE 1 A profile valid for a whole country is named a country profile (see Annex D).

NOTE 2 A profile is derived from base standards so that by definition, conformance to a profile is conformance to the base standards from which it is derived (see Annex A).

4.1.17
required relationship
explicit association between either **spatial units** (4.1.23), or between **basic administrative units** (4.1.2)

NOTE 1 Due to legal aspects, history of data, 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 obligation to refrain from doing something

EXAMPLE 1 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).

EXAMPLE 2 Sequestration can be registered for baunit as a restriction.

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, 4.38]

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** (4.1.23) (e.g. ownership, or usufruct). Personal rights are rights that **parties** (4.1.13) have (e.g. fishing rights, grazing rights, or use 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 legal and/or administrative facts on which the land administration (LA) object [**right** (4.1.20), **restriction** (4.1.19), **responsibility** (4.1.18), **basic administrative unit** (4.1.2), **party** (4.1.13), or **spatial unit** (4.1.23)] is based

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 (4.1.21) with the spatial representation of one (part of) or more **spatial units** (4.1.23)

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

4.1.23
spatial unit
single area (or multiple areas) of **land** (4.1.9) and/or water, or a single volume (or multiple volumes) of space

NOTE 1 A single area is the norm 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** (4.1.2).

NOTE 3 This International 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** (4.1.15), or represented as a set of unstructured lines, or as a surface, or as a 3D volume.

NOTE 4 In addition to spatial units represented by 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** (4.1.23), considered as an entity

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

EXAMPLE Spatial units together forming 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 legal space of 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** (4.1.2).

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 the LADM

5.1 Packages and subpackages of the LADM

The LADM, as a product, is a conceptual schema. The 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 Representation Subpackage (see 5.6) is a subpackage of the Spatial Unit Package.

All figures are UML 2.1 diagrams. The LADM classes are prefixed by LA_ to differentiate them from other classes in the ISO geographic information series of standards.

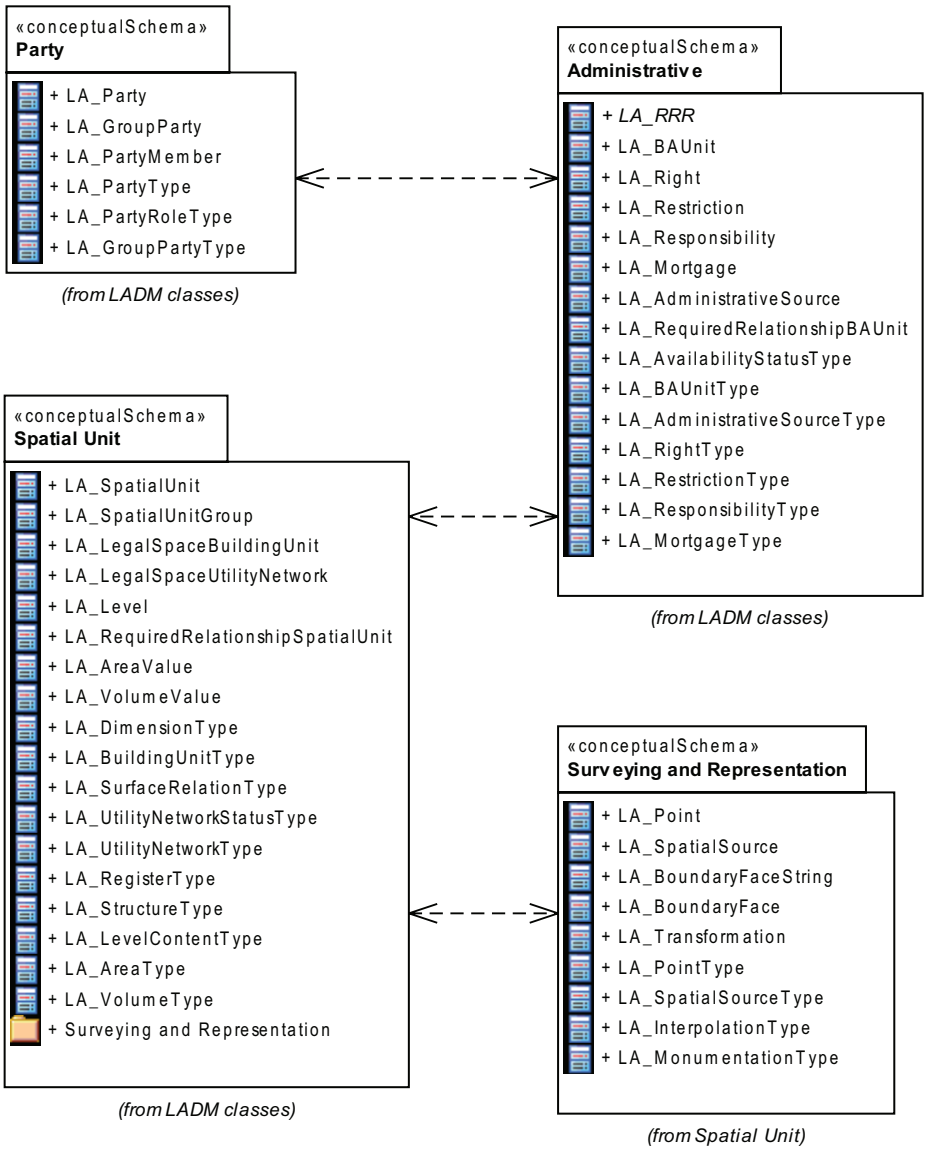


Figure 1 — The LADM overview of (sub)packages (with their respective classes)

5.2 Basic classes of the LADM

The core LADM is based on four basic classes:

1) Class LA_Party. Instances of this class are parties.

2) Class LA_RRR. Instances of subclasses of LA_RRR are rights, restrictions or responsibilities.

3) Class LA_BAUnit. Instances of this class are basic administrative units.

4) Class LA_SpatialUnit. Instances of this class are spatial units.

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

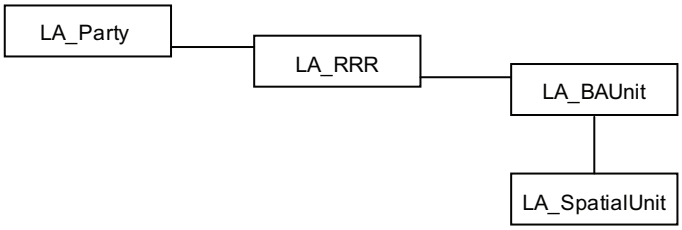


Figure 2 — Basic classes of the LADM

5.3 Party Package

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

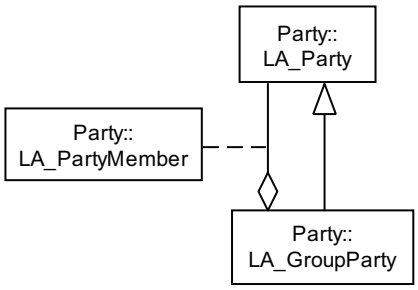


Figure 3 — Classes of Party Package

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 is an abstract class with three specialization classes:

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

2) LA_Restriction, with restrictions as instances. 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.

Instances of class LA_BAUnit are basic administrative units (abbreviated as baunits). 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 shall be 'homogeneous' over the whole baunit). RRR shall be unique 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.

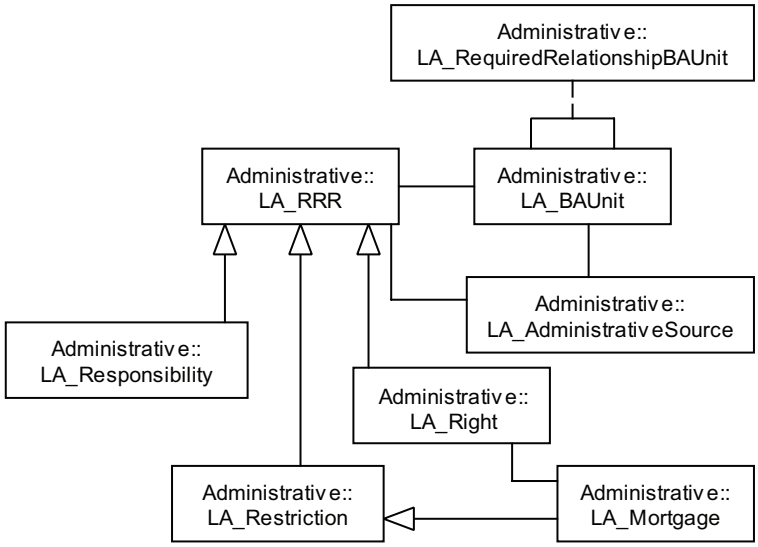


Figure 4 — Classes of Administrative Package

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

Class LA_RequiredRelationshipBAUnit allows for creating instances of relationships between baunits. Relationships can be legal, temporal, or of a spatial nature.

5.5 Spatial Unit Package

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

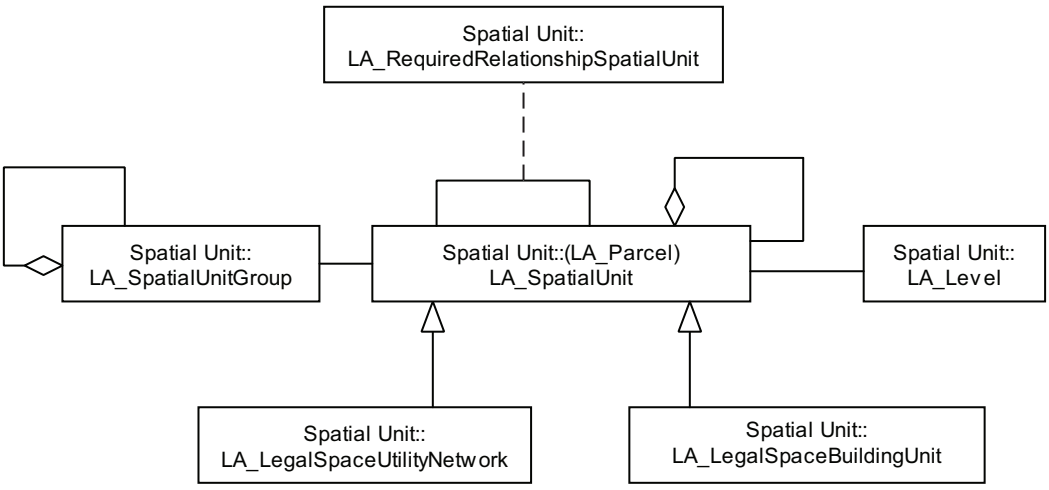


Figure 5 — Classes of Spatial Unit Package

5.5.2 Spatial units may be grouped into two forms:

1) as spatial unit groups, as instances of class LA_SpatialUnitGroup. Spatial unit groups can be further grouped into larger spatial unit groups. This is realised 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 the implementations of the 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 (sub subparcels), and so on.

5.5.3 Spatial units are refined into two specializations:

1) building units, 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, 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.

5.5.4 An instance of LA_Level is a level.

5.5.5 Required relationships are explicit spatial relationships between spatial units, and instances of class LA_RequiredRelationshipSpatialUnit. Sometimes there is a need for these explicit spatial relationships, 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.

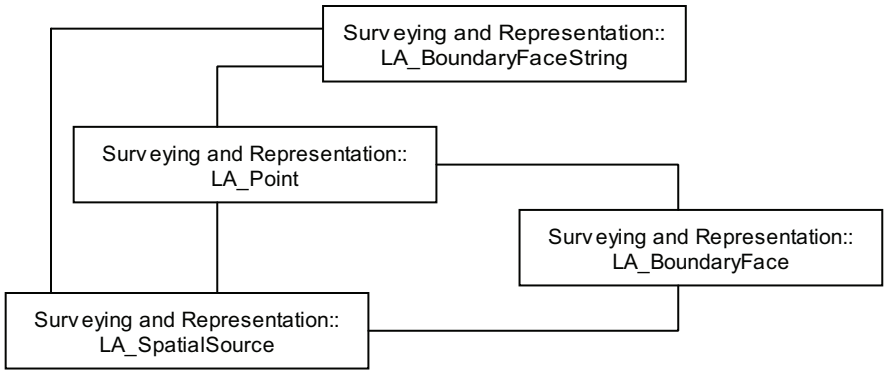


Figure 6 — Classes of Surveying and Representation Subpackage

Points, as instances of LA_Point, lines and surfaces can be acquired in the field (with classical surveys, or with GNSS), in an office, or compiled from various sources, for example using forms, field sketches, ortho-images or orthophotos. The acquisition of points, lines or surfaces (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, 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.

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 the LADM.

2D and 3D representations of spatial units use boundary face strings as instances of class LA_BoundaryFaceString, and boundary faces as instances of class LA_BoundaryFace.

Coordinates themselves either come from points, or are captured as linear geometry.

The 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 the LADM is that there is no mismatch between spatial units that are represented in 2D and spatial units that are represented in 3D. See Annex B for more details. The LADM is based on accepted and available spatial schemata, such as that published in ISO 19107:2003.

6 Content of classes of the LADM and their associations

6.1 Introduction

All LADM classes adhere to ISO/TS 19103 stereotype class featureType (a feature type is a class of features, i.e. abstractions of real world phenomena, having common properties). Many LADM classes are subclasses of class VersionedObject (see 6.2.1).

The 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, building units, utility networks, or archives. See Annex K.

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

6.2 Special classes

6.2.1 VersionedObject

Class VersionedObject is introduced in the 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_PartyMember, 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.

Classes LA_GroupParty, LA_Right, LA_Restriction, LA_Responsibility, LA_Mortgage (via LA_Restriction), LA_LegalSpaceUtilityNetwork and LA_LegalSpaceBuildingUnit inherit VersionedObject through the above classes.

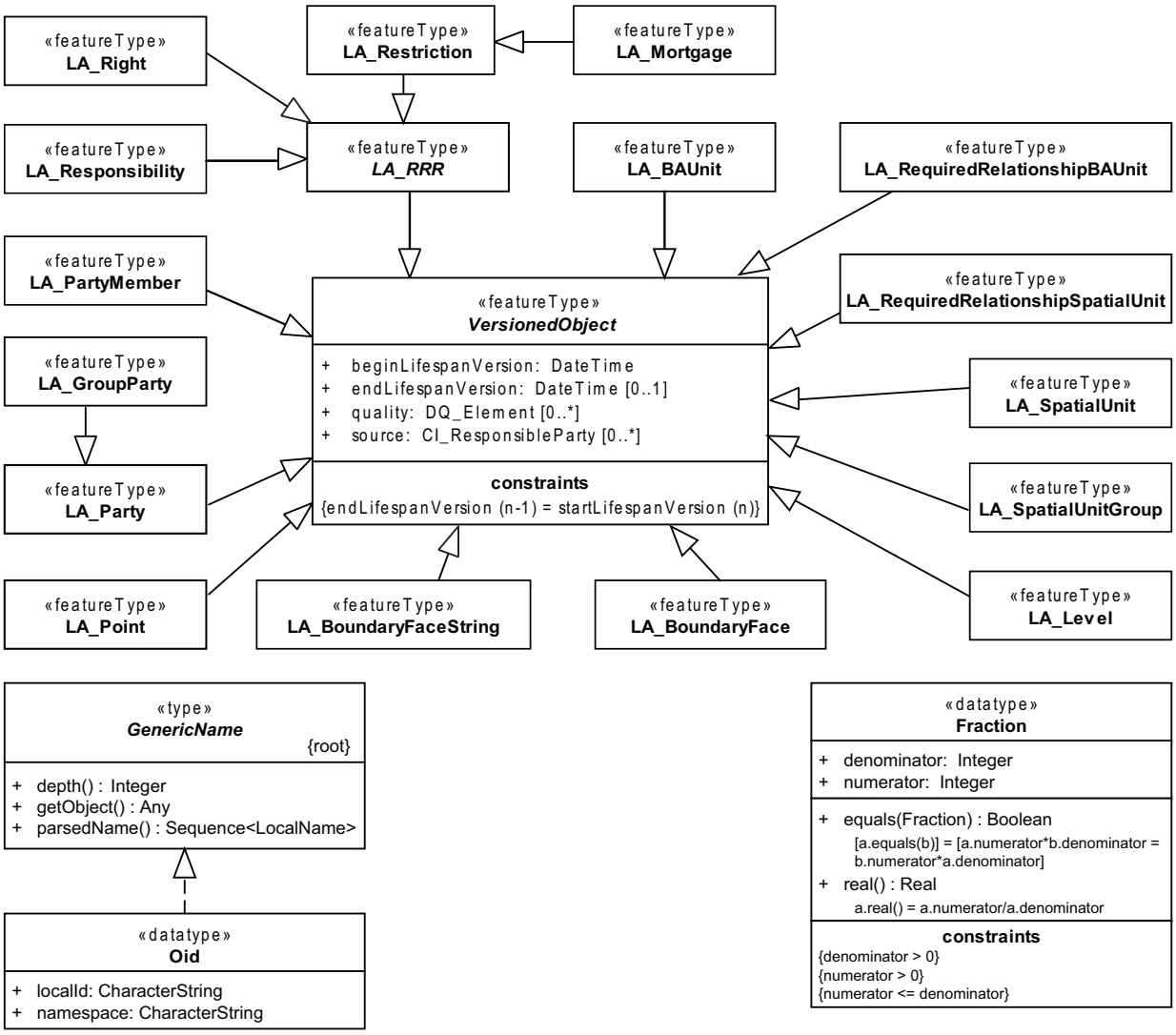


Figure 7 — Classes VersionedObject (with subclasses) Fraction and Oid

The attributes of VersionedObject are:

— beginLifespanVersion: Start time of a specific instance version;

  Value type: DateTime, based on ISO 19108

  Multiplicity: 1

— endLifespanVersion: End time of a specific instance version;

  Value type: DateTime, based on ISO 19103

  Multiplicity: 0..1

— quality: Quality of a specific instance version;

  Value type: DQ_Element (type from ISO 19115)

  Multiplicity: 0..*

— source: Responsible organization of a specific instance version;

Value type: CI_ResponsibleParty (type from ISO 19115)

Multiplicity: 0..*.

6.2.2 Fraction

Generic data type Fraction is introduced in the LADM to provide support for 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 7.

The attributes of Fraction 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

Value type of denominator shall be a positive integer value ≥ 0.

Value type of numerator shall be a positive integer value ≥ 0, and shall be lower than the denominator value.

6.2.3 Oid

Generic data type Oid is introduced in the LADM to provide support for object identifiers, see Figure 7.

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

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

NOTE Country profiles can limit the set of characters to ensure compliancy with local standards (e.g. {“A”..”Z”, “a”..”z”, “0”..”9”, “_”, “.”, “,”, “-“}, i.e. only letters from the Latin alphabet, digits, underscores, periods, commas, and dashes are allowed).

6.2.4 LA_Source

In the 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.

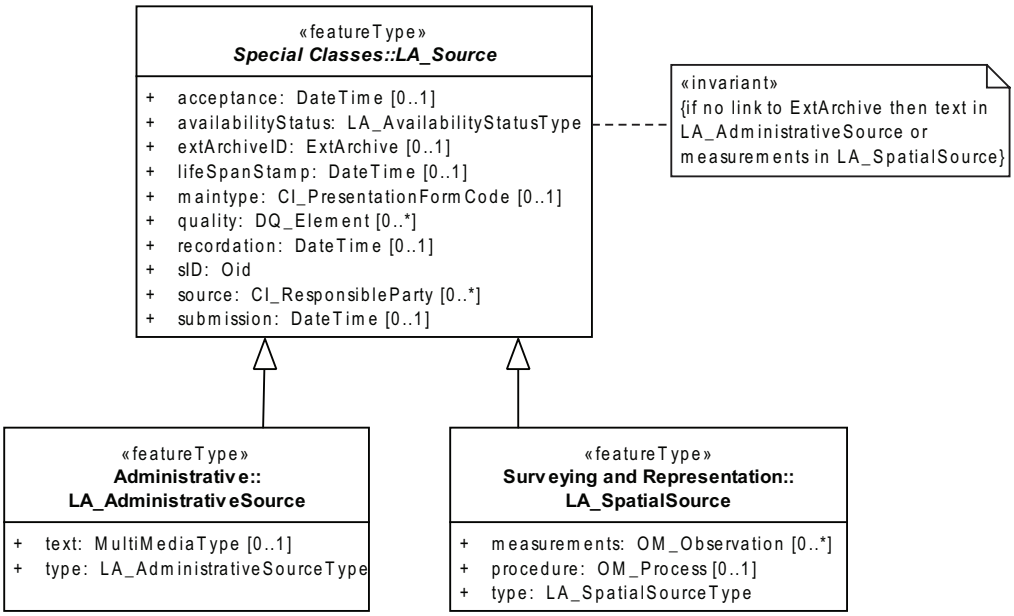


Figure 8 — Class LA_Source (with subclasses)

The attributes of LA_Source are:

— acceptance: The date of force of law of the source by an authority;

Value type: DateTime, based on ISO 19108

Multiplicity: 0..1

— availabilityStatus: The availability status of the source;

Value type: LA_AvailabilityStatusType

Multiplicity: 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, based on ISO 19108

Multiplicity: 0..1

— maintype: The type of document;

Value type: CI_PresentationFormCode

Multiplicity: 0..1

— quality: The quality of the source;

Value type: DQ_Element from ISO 19115

Multiplicity: 0..*

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

Value type: DateTime, based on ISO 19108

Multiplicity: 0..1

— sID: The identifier of the source;

Value type: Oid

Multiplicity: 1

— source: The responsible party of the source;

Value type: CI_ResponsibleParty

Multiplicity: 0..*

— submission: The date of submission of the source by a party;

Value type: DateTime, based on ISO 19108

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 ‘conveyancer’, ‘notary’, or ‘writer’ (see Figure 10).

NOTE 2 In some land administration systems, sources are required to perform the transactions but these are not archived afterwards. The registration itself then serves as such evidence.

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). A party may be associated to zero or more [0..*] administrative sources (i.e. the author of a transfer document is defined as a party playing the role of conveyancer in a source). A party may be associated to zero or more [0..*] spatial sources (i.e. the author of a survey document is defined as a party playing the role of surveyor in a source); see Figure 9.

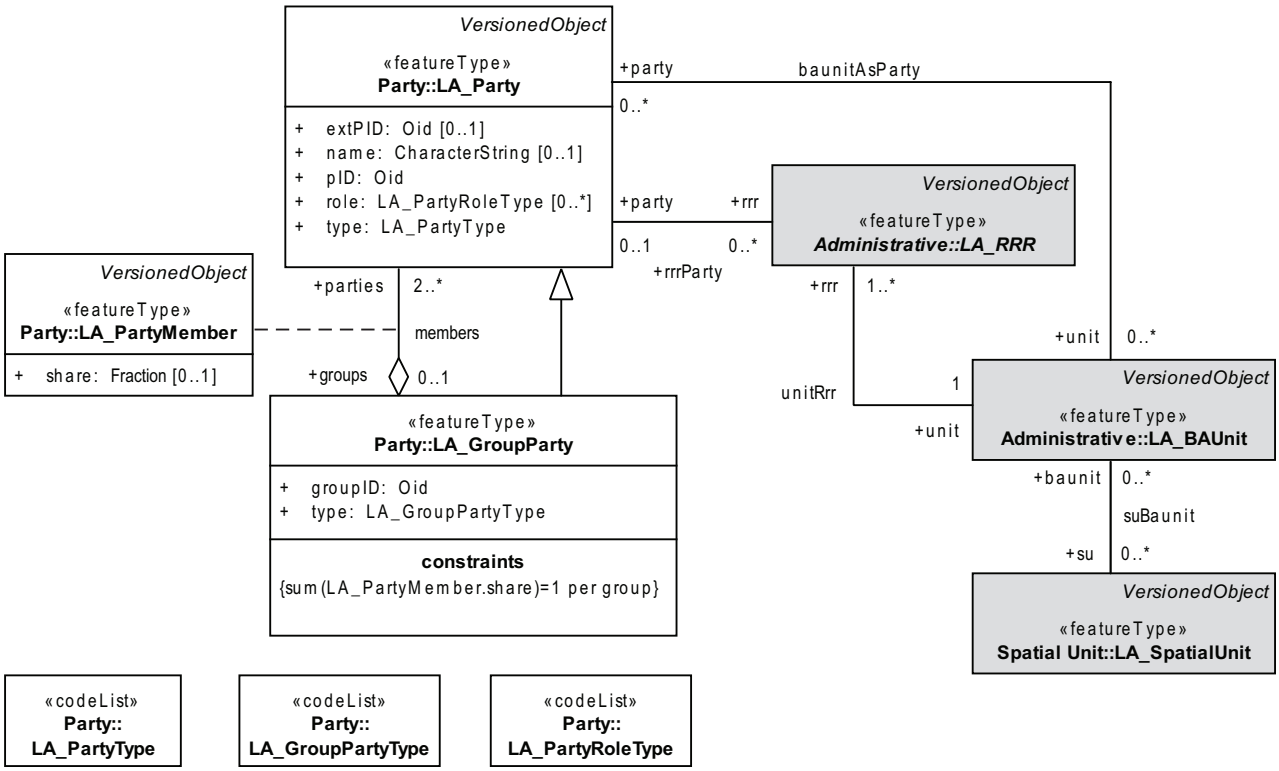


Figure 9 — Content of Party Package and associations to other basic classes

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. conveyancer) then it is possible that no subclasses of LA_RRR are associated to the party, hence [0..*] multiplicity, 0 indicating that, e.g. this conveyancer is not involved in any subclass of LA_RRR.

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

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 consists 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

LA_GroupParty has a constraint requiring that the sum of the shares of the group party members shall equal 1. This constraint is only enforced if a class LA_PartyMember exists (see 6.3.3).

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

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: Fraction

Multiplicity: 0..1

6.3.4 Code lists for Party Package

Party Package has three code lists (see Figure 9). See Annex J for examples of the values.

— LA_PartyRoleType: the LA_PartyRoleType code list includes all the various roles, such as surveyor or notary, parties may play in updating and/or maintaining the land administration in a specific land

administration profile implementation. The LA_PartyRoleType code list is required only if the attribute role in LA_Party class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_GroupPartyType: the LA_GroupPartyType code list includes all the various types of group parties, such as association or family, recognized/allowed in a specific land administration profile implementation. The LA_GroupPartyType code list is required to implement the LA_GroupParty class. The code list shall provide a complete list of all codes with a name and description.

— LA_PartyType: the LA_PartyType code list includes all the various types of parties, such as natural or non natural persons, recognized/allowed in a specific land administration profile implementation. The LA_PartyType code list is required to implement the LA_Party class. The code list shall provide a complete list of all codes with a name and description.

6.4 Classes of Administrative Package

6.4.1 LA_BAUnit

An instance of class LA_BAUnit is a basic administrative unit. LA_BAUnit is associated to class LA_Party (a party may be a basic administrative unit). A basic administrative unit is associated to zero or more [0..*] spatial units. A basic administrative unit shall be associated to one or more [1..*] instances of right, restriction or responsibility (i.e. a basic administrative unit cannot exist if there is not at least one right, restriction or responsibility associated to it). A basic administrative unit can be spatially related, through a required relationship, to zero or more [0..*] other basic administrative units (i.e. create an explicit spatial relationship between two basic administrative units when the geometry is missing or inaccurate to provide reliable implicit results). Basic administrative units do not need to be related explicitly. However, if an explicit required relationship is specified, a basic administrative unit shall be associated to one or more [1..*] other basic administrative units. A basic administrative unit can be associated to zero or more [0..*] administrative sources (i.e. the basic administrative unit is usually described as the object affected by the right, restriction or responsibility in the administrative source). A basic administrative unit can be associated to zero or more [0..*] spatial sources (i.e. the extent – part of – of a basic administrative unit can be described on a spatial source). 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

LA_BAUnit has a constraint requiring that the sum of all the shares for one basic administrative unit shall equal 1 for the same subclass of class LA_RRR, unless ‘share’ is meaningless with regard to the type of right, restriction or responsibility. The constraint should be applied only to instances valid at the same moment in time (life span).

LA_BAUnit has a constraint requiring that no overlap be allowed between timeSpecs for the same RRR type and the same basic administrative unit.

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

NOTE 2 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 3 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 4 A (group of) baunits may be a party.

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

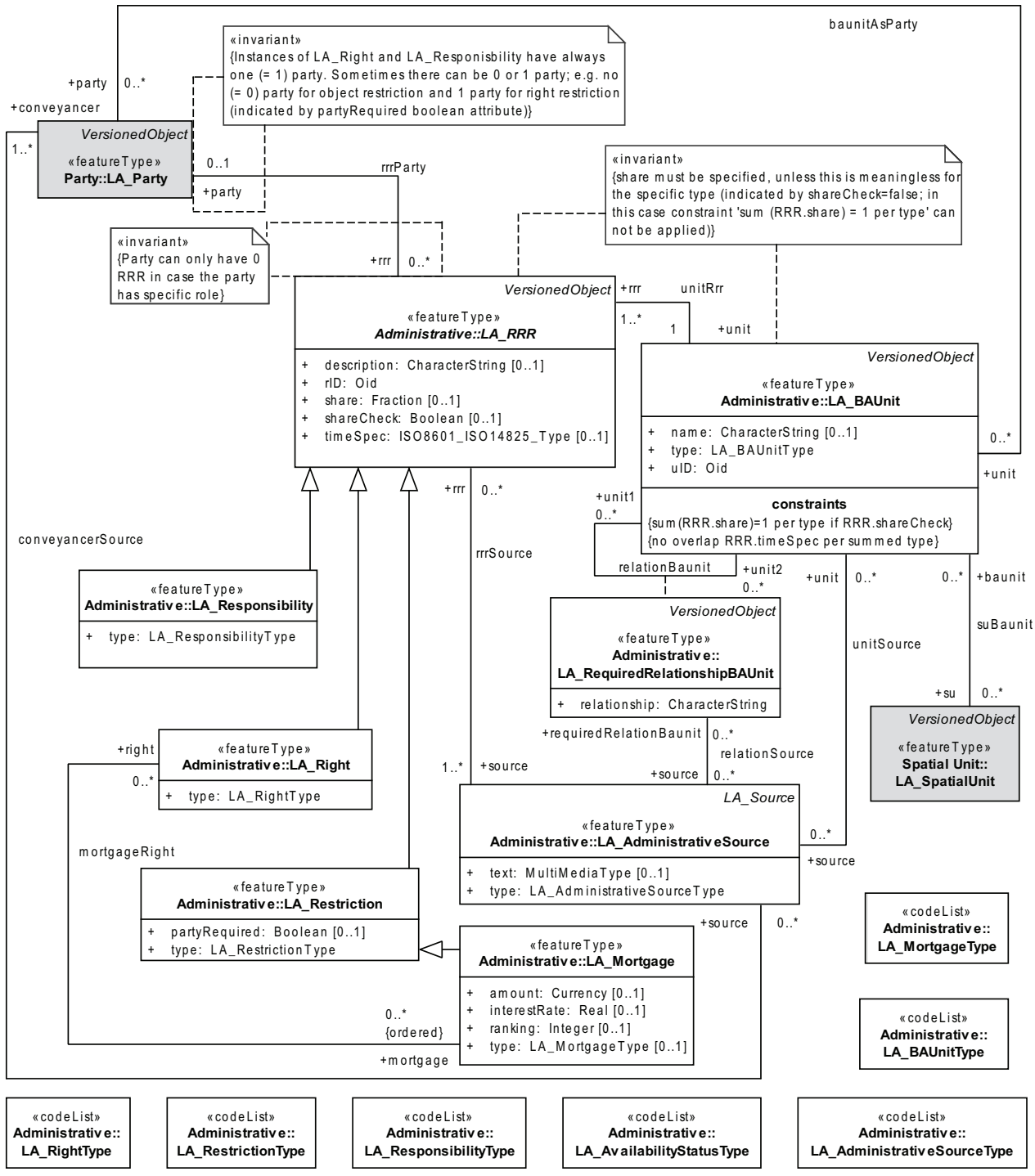


Figure 10 — Content of Administrative Package with associations to other basic classes

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. An instance of a subclass of LA_RRR shall be associated to one or more [1..*] administrative sources (i.e. the right, restriction or

responsibility affecting a basic administrative unit shall be supported by at least one administrative source). 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: Fraction

  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 or ISO 14825 type

  Multiplicity: 0..1

NOTE 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 14825:2011, Annex D; ISO 14825:2011, Annex D may be used instead of ISO 8601:2004).

6.4.3 LA_Right

An instance of class LA_Right is a right. LA_Right is a subclass of class LA_RRR. A right may be associated to zero or more [0..*] mortgages (i.e. a mortgage is associated to the affected basic administrative unit but it may also be specifically associated to the right which is the object of the mortgage); 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 Annex C, Figures C.1, C.8, C.11, C.30 and C.31.

6.4.4 LA_Restriction

An instance of class LA_Restriction is a restriction. LA_Restriction is a subclass of class LA_RRR. LA_Mortgage is a specialization of LA_Restriction (6.4.6); see 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 a spatial unit restriction. The spatial unit restriction is always via a baunit.

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

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 Annex C, Figure C.20.

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). A mortgage can be associated to zero or more [0..*] rights (i.e. a mortgage can be associated specifically to the right which is the object of the mortgage). In all cases, the mortgage is associated, through LA_Restriction and LA_RRR, to the basic administrative unit which is affected by the mortgage; see Figure 10.

The attributes of LA_Mortgage are:

— amount: The amount of money of the mortgage;

  Value type: Currency, based on ISO 4217

  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 Annex C, Figures C.10, C.11 and C.15.

6.4.7 LA_AdministrativeSource

An instance of class LA_AdministrativeSource is an administrative source. LA_AdministrativeSource is a subclass of class LA_Source. An administrative source shall be associated to one or more [1..*] parties (i.e. as a minimum the party playing the role of conveyancer must be specified). An administrative source may be associated to zero or more [0..*] basic administrative units (i.e. the administrative source may describe the objects of the right, restriction or responsibility). An administrative source may be associated to zero or more [0..*] instances of specializations (right, restriction/mortgage, and responsibility) of LA_RRR (i.e. the administrative source may describe the rights, restrictions or responsibilities hold by a party and affecting a basic administrative unit); see Figures 8 and 10.

The attributes of LA_AdministrativeSource are:

— text: The content of the document;

Value type: MultiMediaType based on ISO/IEC 13240

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 may be used for the content of the document.

NOTE 3 Archives can be internal or external to the LA organization. If internal then text attribute can be used; if external then extArchiveID of administrative source.

6.4.8 LA_RequiredRelationshipBAUnit

An instance of association class LA_RequiredRelationshipBAUnit is a required relationship between basic administrative units, see Figure 10. A required relationship between spatial units can be associated to zero or more [0..*] spatial sources to provide supporting documentation for the explicit relationship.

The attribute of LA_RequiredRelationshipBAUnit is:

— relationship: The description of the required relationship;

Value type: CharacterString

Multiplicity: 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'.

EXAMPLE Two historic versions of baunits should be connected in time when related to the same change, e.g. when a part of a spatial unit is sold.

6.4.9 Code lists for Administrative Package

Administrative Package has seven code lists for classes. See Annex J for examples of the values.

— LA_AdministrativeSourceType: the LA_AdministrativeSourceType code list includes all the various administrative source types, such as deed or title, used as supporting documents in a specific land administration profile implementation. The LA_AdministrativeSourceType code list is required to implement the LA_AdministrativeSource class. Code list shall provide a complete list of all codes with a name and description.

— LA_MortgageType: the LA_MortgageType code list includes all the various mortgage types, such as linear or micro-credit, used in a specific land administration profile implementation. The LA_MortgageType code list is required only if the attribute type in LA_Mortgage class is implemented. Code list shall provide a complete list of all codes with a name and description.

— LA_RightType: the LA_RightType code list includes all the various right types, such as ownership, customary or lease, used in a specific land administration profile implementation. The LA_RightType code list is required to implement the LA_Right class. Code list shall provide a complete list of all codes with a name and description.

— LA_RestrictionType: the LA_RestrictionType code list includes all the various restriction types, such as servitudes, used in a specific land administration profile implementation. The LA_RestrictionType code list is required to implement the LA_Restriction class. Code list shall provide a complete list of all codes with a name and description.

— LA_ResponsibilityType: the LA_ResponsibilityType code list includes all the various responsibility types, such as waterway maintenance, used in a specific land administration profile implementation. The LA_ResponsibilityType code list is required to implement the LA_Responsibility class. Code list shall provide a complete list of all codes with a name and description.

— LA_AvailabilityStatusType: the LA_AvailabilityStatusType code list includes all the various availability status types, such as original, destroyed or incomplete, used in a specific land administration profile implementation. The LA_AvailabilityStatusType code list is required to implement the LA_AdministrativeSource class. Code list shall provide a complete list of all codes with a name and description.

— LA_BAUnitType: the LA_BAUnitType code list includes all the various basic administrative unit types, such as basic property unit or right unit, used in a specific land administration profile implementation. The LA_BAUnitType code list is required to implement the LA_BAUnit class. Code list shall provide a complete list of all codes with a name and description.

6.5 Classes of Spatial Unit Package

6.5.1 LA_SpatialUnit

An instance of class LA_SpatialUnit is a spatial unit. A spatial unit may be associated to zero or more [0..*] basic administrative units (i.e. the spatial unit may be used to describe the extent – part of – a basic administrative unit). A spatial unit may be associated to zero or one [0..1] levels (i.e. a spatial unit can be associated to a property level). A spatial unit cannot be associated to more than one level. A spatial unit may be associated to zero or more [0..*] spatial unit groups (i.e. a spatial unit can be associated to a subdivision and also to school district). A spatial unit can be spatially related, through a required relationship, to zero or more [0..*] other spatial units (i.e. creates an explicit spatial relationship between two spatial units when the geometry is missing or inaccurate to provide reliable implicit results). Spatial units do not need to be related explicitly. A spatial unit can be associated to zero or more [0..*] spatial sources. A spatial unit can form part of 0..1 other spatial unit. A spatial unit can include 0..* other spatial units. Spatial units can be further specialized into building units (6.5.3) or utility networks (6.5.4); 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 (type from ISO 19107)

  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_SurfaceRelationType

  Multiplicity: 0..1

— volume: The volume of the 3D spatial unit;

  Value type: LA_VolumeValue

  Multiplicity: 0..*

NOTE The method 'createArea( )' constructs geometric primitive of type GM_MultiSurface based on associated spatial representation (2D). The method 'areaClosed( )' checks if associated spatial representation is closed (2D). The method 'computeArea( )' computes area of associated spatial representation (2D). The method 'computeVolume( )' computes volume of associated spatial representation (3D). The method 'createVolume( )' constructs geometric primitive of type GM_MultiSolid based on associated spatial representation (3D). The method 'volumeClosed( )' checks if associated spatial representation is closed (3D). These methods define meaning of class at conceptual level, and are not inherited from other classes, nor defined in other ISO standards. Not all methods are meaningful in all situations, e.g. computeVolume() in case of 2D.

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

6.5.2 LA_SpatialUnitGroup

An instance of class LA_SpatialUnitGroup is a spatial unit group. A spatial unit group is made of one or more [1..*] parts/elements (which can be spatial units, or spatial unit groups, or a combination of spatial units and spatial unit groups). A spatial unit group is part of zero or one [0..1] larger spatial unit group, which again can even be part of zero or one [0..1] larger spatial unit group, and so on. 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 (type from ISO 19107)

  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:

— extPhysicalBuildingUnitID: The identifier of the building unit;

Value type: extPhysicalBuildingUnit

Multiplicity: 0..1

— type: The type of the building unit;

Value type: LA_BuildingUnitType

Multiplicity: 0..1

NOTE The extBuildingUnitID is optional, as in most cases, the suID inherited from LA_SpatialUnit is sufficient to uniquely identify instances of LA_LegalSpaceBuildingUnit.

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

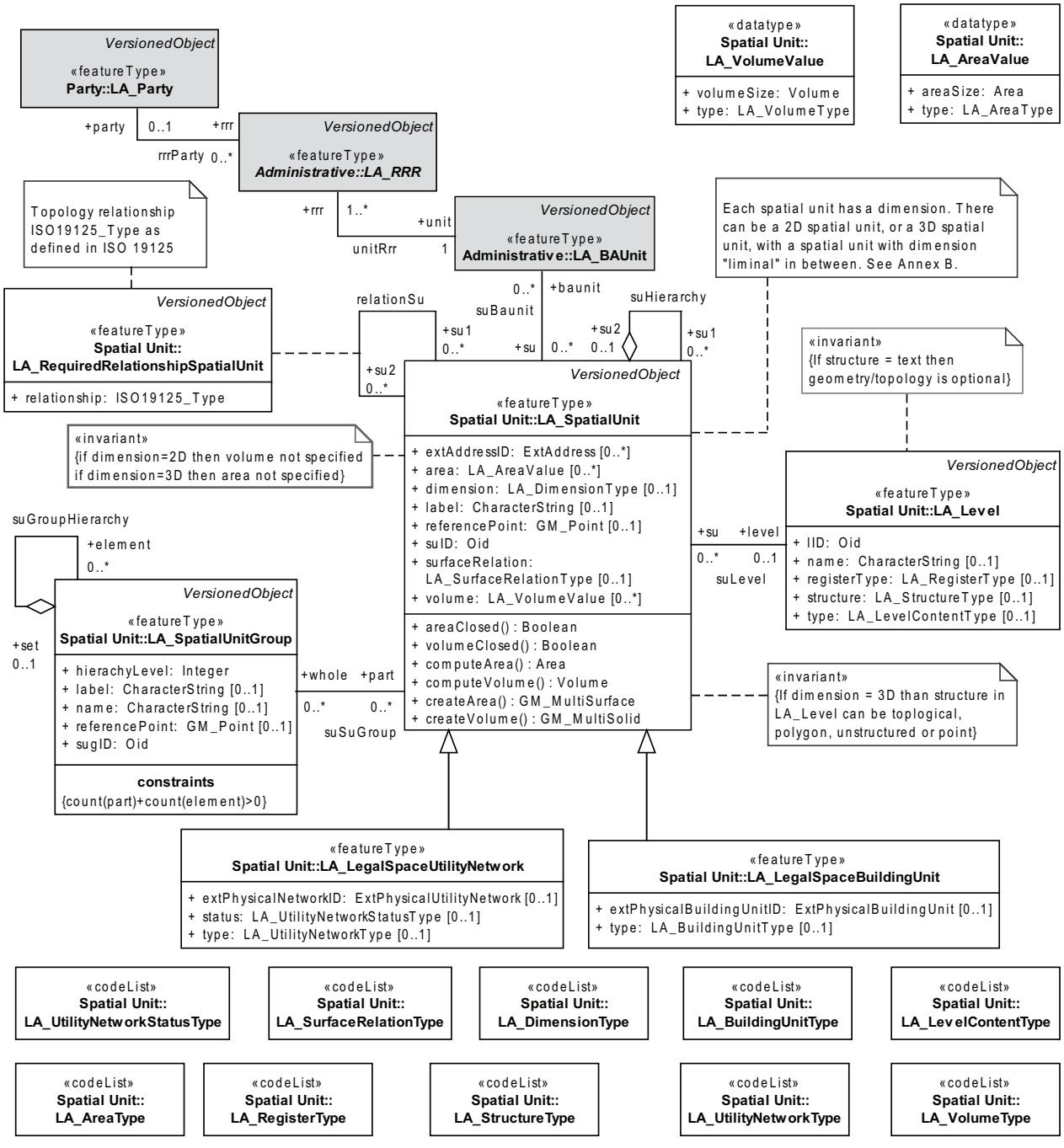


Figure 11 — Content of Spatial Unit Package with associations to other basic classes

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 Annex C, Figure C.15.

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:

— lID: 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: 0..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 Annex C, Figures C.2, C.14, C.16, C.21, C23, C.24, C.25 and C.32.

6.5.6 LA_RequiredRelationshipSpatialUnit

An instance of association class LA_RequiredRelationshipSpatialUnit is a required relationship between spatial units, see Figures 11 and 12. A required relationship between spatial units can be associated to zero or more [0..*] spatial sources to provide supporting documentation for the explicit relationhip.

The attribute of LA_RequiredRelationshipSpatialUnit is:

— relationship: The description of the required relationship;

Value type: ISO 19125-2 spatial type

Multiplicity: 1

6.5.7 Data types for Spatial Unit Package

The Spatial Unit Package has two data types: LA_AreaValue and LA_VolumeValue. The generic data type LA_AreaValue is introduced in LADM to provide support for registering the various types of area values (see Annex J). The generic data type LA_VolumeValue is introduced in LADM to provide support for various types of volume values (see Annex J).

The attributes of LA_AreaValue are:

— areaSize: Area of the 2D spatial unit;

Value type: Area

Multiplicity: 1

— type: Indicates the type of area provided;

Value Type: LA_AreaType

Multiplicity: 1

The attributes of LA_VolumeValue are:

— volumeSize: Volume of the 3D spatial unit;

Value type: Volume

Multiplicity: 1

— type: Indicates the type of volume provided;

Value Type: LA_VolumeType

Multiplicity: 1

6.5.8 Code lists for Spatial Unit Package

The Spatial Unit Package has ten code lists (see Figure 11). See Annex J for examples of the values.

— LA_BuildingUnitType: the LA_BuildingUnitType code list includes all the various building unit types, such as private or commercial, used in a specific land administration profile implementation. The LA_BuildingUnitType code list is required only if the attribute type in LA_LegalSpaceBuildingUnit class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_AreaType: the LA_AreaType code list includes all the various area types, such as official or calculated, used in a specific land administration profile implementation. The LA_AreaType code list is required to implement the LA_AreaValue data type. The code list shall provide a complete list of all codes with a name and description.

— LA_VolumeType: the LA_VolumeType code list includes all the various volume types, such as official or calculated, used in a specific land administration profile implementation. The LA_VolumeType code list is required to implement the LA_VolumeValue data type. The code list shall provide a complete list of all codes with a name and description.

— LA_SurfaceRelationType: the LA_SurfaceRelationType code list includes all the various surface relation types, such as above or below surface, used in a specific land administration profile implementation. The LA_SurfaceRelationType code list is required only if the attribute surfaceRelation in LA_SpatialUnit class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_DimensionType: the LA_DimensionType code list includes all the various dimension types, such as 2D or 3D, used in a specific land administration profile implementation. The LA_DimensionType code list is required only if the attribute dimension in LA_SpatialUnit class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_UtilityNetworkStatusType: the LA_UtilityNetworkStatusType code list includes all the various utility network status types, such as planned or in use, used in a specific land administration profile implementation. The LA_UtilityNetworkStatusType code list is required only if the attribute status in LA_LegalSpaceUtilityNetwork class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_RegisterType: the LA_RegisterType code list includes all the various register types, such as rural or urban, used in a specific land administration profile implementation. The LA_RegisterType code list is required only if the attribute registerType in LA_Level class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_UtilityNetworkType: the LA_UtilityNetworkType code list includes all the various utility network types, such as electricity or gas, used in a specific land administration profile implementation. The LA_UtilityNetworkType code list is required only if the attribute type in LA_LegalSpaceUtilityNetwork class is implemented. The code list must provide a complete list of all codes with a name and description.

— LA_LevelContentType: the LA_LevelContentType code list includes all the various level content types, such as primary right or customary, used in a specific land administration profile implementation. The LA_LevelContentType code list is required only if the attribute type in LA_Level class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_StructureType: the LA_StructureType code list includes all the various spatial structure types, such as point or polygon, used in a specific land administration profile implementation. The LA_StructureType code list is required only if the attribute structure in LA_Level class is implemented. The code list shall provide a complete list of all codes with a name and description.

6.6 Classes of Surveying and Representation Subpackage

6.6.1 LA_Point

An instance of class LA_Point is a point. A point may be associated to zero or one [0..1] spatial units (i.e. the point may be used as the reference point to describe the position of a spatial unit). A point may be associated to zero or more [0..*] boundary faces (i.e. a point may be used to define a vertex of the side of a 3D parcel). A point may be associated to zero or more [0..*] boundary face strings (i.e. a point can be used to define the start, end or vertex of a boundary). A point should be associated to zero or more [0..*] spatial sources. See Figure 12.

The attributes of LA_Point are:

— estimatedAccuracy: The estimated accuracy of the point;

Value type: DQ_AbsoluteExternalPositionalAccuracy

Multiplicity: 0..1

— interpolationRole: The role of the 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 coordinates, based on measurements and observations;

Value type: GM_Point (type from ISO 19107)

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..*

NOTE The method 'getTransResult( )' returns the transformed point (GM_Point), and is not inherited from other classes, nor defined in other ISO international standards.

6.6.2 LA_SpatialSource

An instance of class LA_SpatialSource is a spatial source. A set of measurements with observations (distances, bearings, GPS-coordinates, etc.) of points, is an attribute of LA_SpatialSource. LA_SpatialSource is a subclass of class LA_Source. A spatial source shall be associated to one or more [1..*] points (i.e. the spatial source describes in all cases one or more points). If the spatial source does not describe at least one point, it would not be a spatial source. A spatial source may be associated to zero or more [0..*] boundary face strings (i.e. the spatial source describes the boundary of a 2D spatial unit). A spatial source may be associated to zero or more [0..*] boundary faces (i.e. the spatial source describes the side of a 3D spatial unit). A spatial source may be associated to zero or more [0..*] spatial units (i.e. the spatial source describes the extent of a spatial unit). A spatial source may be associated to zero or more [0..*] basic administrative units (i.e. the spatial source describes the extent of a property). A spatial source shall be associated to one or

more [1..*] parties (i.e. as a minimum the party playing the role of author of the spatial source, the surveyor, should be specified). See Figures 8 and 12.

The attributes of LA_SpatialSource are:

— measurements: The observations and measurements;

  Value type: OM_Observation, based on ISO 19156

  Multiplicity: 0..*

— procedure: The survey method used;

  Value type: OM_Process, based on ISO 19156

  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 relationship to LA_BAUnit can be obtained via LA_SpatialUnit.

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. In the case of a location by text, a boundary face string would not be defined by points. However, in all other cases, a boundary face string shall be defined by two or more [2..*] points (i.e. as a minimum a boundary starts and ends at a point, i.e. a straight line).

NOTE In case the boundary face string is defined by text, then no points are associated; in case the boundary face string is not defined by text, then at least two points are associated (defining the boundary face string).

In the association between LA_BoundaryFaceString and LA_SpatialUnit, a + (plus) means that the associated boundary face string has the same orientation within the spatial unit, and a – (minus) means that the associated boundary face string has the opposite orientation within the spatial unit. A boundary face string may be associated to zero or more [0..*] spatial sources (i.e. the boundary of a spatial unit can be described on one or more spatial sources, on the spatial source creating the spatial unit and on the spatial source creating the neighbouring spatial unit); 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 (type from ISO 19107)

  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 Annex C, Figure C.33.

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. In the case of a location by text, a boundary face will not be defined by points. However, in all other cases, a boundary face shall be defined by three or more [3..*] points (i.e. as a minimum, a triangle face is defined by three points). A boundary face may be associated to zero or more [0..*] spatial sources (i.e. the face of a 3D spatial unit can be described on one or more spatial sources, on the spatial source creating the spatial unit and the spatial source creating the neighbouring spatial unit). The orientation of the boundary that is equal to the orientation of the spatial unit is the “+” association, otherwise “-”. 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 (type from ISO 19107)

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 Annex C, Figure C.7.

6.6.5 Data types for Surveying and Representation Subpackage

The Surveying and Representation Subpackage has one data type: LA_Transformation. The generic data type LA_Transformation is introduced in LADM to provide support for transformations of coordinates between two reference systems.

The attributes of LA_Transformation are:

— transformation: Description of the transformation method used to obtain the associated location value;

Value type: CC_OperationMethod (from ISO 19111)

Multiplicity: 1

— transformedLocation: Location obtained from the transformation operation method;

Value Type: GM_Point (type from ISO 19107)

Multiplicity: 1

6.6.6 Code lists for Surveying and Representation Subpackage

The Surveying and Representation Subpackage has four code lists (see Figure 12). See Annex J for examples of the values.

— LA_MonumentationType: the LA_MonumentationType code list includes all the various monumentation types, such as beacon or marker, used in a specific land administration profile implementation. The LA_MonumentationType code list is required only if the attribute monumentation in LA_Point class is implemented. The code list shall provide a complete list of all codes with a name and description.

— LA_SpatialSourceType: the LA_SpatialSourceType code list includes all the various spatial source types, such as survey plan or aerial photograph, used in a specific land administration profile implementation. The LA_SpatialSourceType code list is required to implement the LA_SpatialSource class. The code list shall provide a complete list of all codes with a name and description.

— LA_InterpolationType: the LA_InterpolationType code list includes all the various point interpolation types, such as start, end or mid arc, applicable in a specific land administration profile implementation. The LA_InterpolationType code list is required to implement the LA_Point class. The code list shall provide a complete list of all codes with a name and description.

— LA_PointType: the LA_PointType code list includes all the various point types, such as control or cadastral, applicable in a specific land administration profile implementation. The LA_PointType code list is required to implement the LA_Point class. The code list shall provide a complete list of all codes with a name and description.

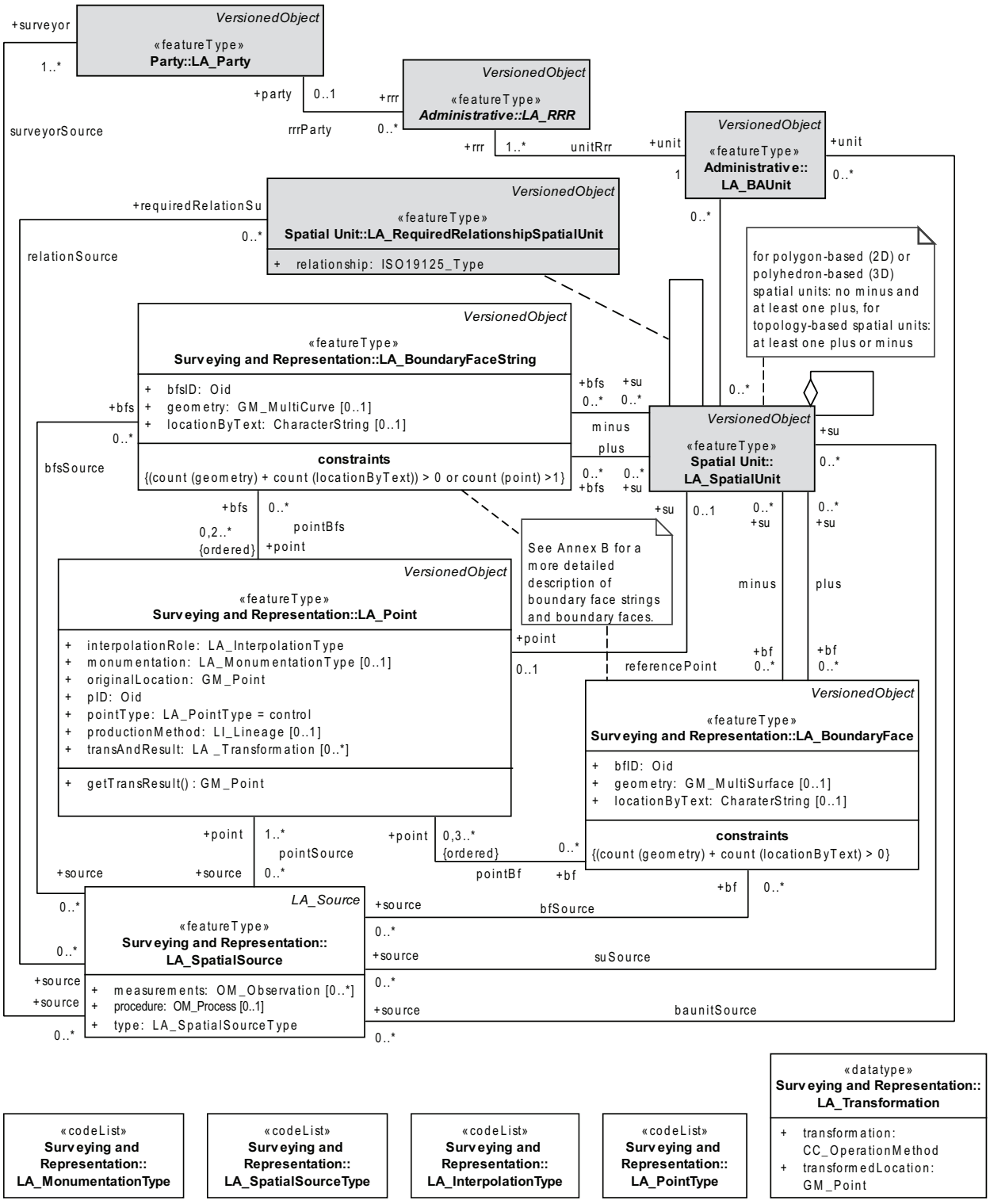


Figure 12 — Content of Surveying and Representation Subpackage with associations to other (basic) classes

6.7 Associations between classes

In this subclause, three tables summarize all the relationships between the LADM classes: for associations between classes, see Table 1; for generalizations between classes, see Table 2; and for aggregations between classes, see Table 3.

Table 1 — Associations between the LADM classes

Class 1[a]	Class 2[a]	Association name	Role name End 1	Multi-plicity	Role name End 2	Multi-plicity
AdministrativeSource	BAUnit	unitSource	source	0..*	unit	0..*
AdministrativeSource	Party	conveyancerSource	source	0..*	conveyancer	1..*
AdministrativeSource	RRR	rrrSource	source	1..*	rrr	0..*
AdministrativeSource	RequiredRelationship-BAUnit	relationSource	source	0..*	required RelationBaunit	0..*
BAUnit	BAUnit	relationBaunit	unit1	0..*	unit2	0..*
BAUnit	RRR	baunitRrr	unit	1	rrr	1..*
BoundaryFace	SpatialSource	bfSource	bf	0..*	source	0..*
BoundaryFace	SpatialUnit	minus	bf	0..*	su	0..*
BoundaryFace	SpatialUnit	plus	bf	0..*	su	0..*
BoundaryFaceString	SpatialSource	bfsSource	bfs	0..*	source	0..*
BoundaryFaceString	SpatialUnit	minus	bfs	0..*	su	0..*
BoundaryFaceString	SpatialUnit	plus	bfs	0..*	su	0..*
Mortgage	Right	mortgageRight	mortgage	0..*	right	0..*
Party	BAUnit	baunitAsParty	party	0..*	unit	0..*
Party	GroupParty	members	parties	2..*	group	0..1
Point	BoundaryFace	pointBf	point	0,3..*	bf	0..*
Point	BoundaryFaceString	pointBfs	point	0,2..*	bfs	0..*
RRR	Party	rrrParty	rrr	0..*	party	0..1
SpatialSource	BAUnit	baunitSource	source	0..*	unit	0..*
SpatialSource	Party	surveyorSource	source	0..*	surveyor	1..*
SpatialSource	RequiredRelationship-SpatialUnit	relationSource	source	0..*	required RelationshipSu	0..*
SpatialSource	Point	pointSource	source	0..*	point	1..*
SpatialUnit	BAUnit	suBaunit	su	0..*	baunit	0..*
SpatialUnit	Level	suLevel	su	0..*	level	0..1
SpatialUnit	Point	referencePoint	su	0..1	point	0..1
SpatialUnit	SpatialSource	suSource	su	0..*	source	0..*
SpatialUnit	SpatialUnit	relationSu	su1	0..*	su2	0..*
SpatialUnit	SpatialUnit	suHierarchy	su1	0..*	su2	0..1
SpatialUnit	SpatialUnitGroup	suSuGroup	part	0..*	whole	0..*
SpatialUnitGroup	SpatialUnitGroup	suGroupHierarchy	element	0..*	set	0..1

[a] The LA prefix of class names has been omitted due to space reasons.

Table 2 — Generalizations between the LADM classes

Superclass[a]	Subclass[a]
Restriction	Mortgage
RRR	Right
RRR	Restriction
RRR	Responsibility
Party	GroupParty
Source	AdministrativeSource
Source	SpatialSource
SpatialUnit	LegalSpaceBuildingUnit
SpatialUnit	LegalSpaceUtilityNetwork
VersionedObject	*RRR*
VersionedObject	BAUnit
VersionedObject	RequiredRelationshipBAUnit
VersionedObject	RequiredRelationshipSpatialUnit
VersionedObject	SpatialUnit
VersionedObject	SpatialUnitGroup
VersionedObject	Level
VersionedObject	BoundaryFace
VersionedObject	BoundaryFaceString
VersionedObject	Point
VersionedObject	Party
VersionedObject	PartyMember

[a] The LA prefix of class names has been omitted due to space reasons.

Table 3 — Aggregations between the LADM classes

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

[a] The LA prefix of class names has been omitted due to space reasons.

Annex A
(normative)

Abstract test suite

A.1 Introduction

A.1.1 The abstract test suite is in conformance with ISO 19105. The LADM specifies a conceptual schema. Actual use of the LADM requires that an application schema, such as a country profile, be developed. This Annex specifies how to test whether a specific application schema is conformant with the LADM in terms of package and level. Testing whether a specific data set is conformant, means checking the data set content against the corresponding conformant LADM application schema (package and level).

A.1.2 This test suite specifies the requirements that the 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 one subpackage, and for each of them a conformance test is specified. Three conformance levels are specified per (sub)package: level 1 (low level), level 2 (medium level), and level 3 (high level). A package is level 1 compliant if the classes with level 1 indicators are passing the conformance test. A package is level 2 compliant if the classes with levels 1 or 2 indicators are passing the conformance test. A package is level 3 compliant if the classes with level 1, 2 or 3 indicators are passing the conformance test.

Table A.1 gives an overview per package to check for LADM compliancy. Conformance tests on the LADM can be done per package. Conformance tests shall be done on interdependencies between applicable packages when two or more packages are tested. The mandatory and optional attributes are given in the class diagrams. The same holds for associations (also in case of interdependencies).

A.1.3 The test method in this Annex is used in all test cases 'to examine the application schema of the 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 the LADM and the tested model (elements), or

2) Show mapping of elements between the LADM and the tested model.

The test is documented per class in A.2 to A.4.

NOTE 1 In order to realize this conformance test explicitly and completely, knowledge and understanding is required of both the LADM and any specific profile used. The profile should not include different structures or solutions where the LADM has standard provisions.

NOTE 2 Conformance testing per right type, responsibility type or restriction type is possible. In the code lists for rights, responsibilities or restrictions, specific (user defined) code list values can be added, indicating a partial responsibility or restriction or a right, which is not homogeneous in time. This affects the complete spatial unit with regard to registration (therefore in a sense homogeneous), but in reality only a part of the spatial unit. In addition, a text spatial unit can be defined, describing the location of the part.

Table A.1 — The LADM conformance requirements table

LADM package	LADM class	CI[a]	Dependencies
-	*VersionedObject*	1	
	LA_Source	1	Oid, (as a minimum one of the specializations must be implemented [LA_AdministrativeSource or LA_SpatialSource]), LA_AvailabilityStatusType
Party Package			Exist only if Administrative Package is implemented
	LA_Party	1	VersionedObject, Oid, LA_PartyType
	LA_GroupParty	2	Oid, LA_Party, LA_GroupPartyType
	LA_PartyMember	2	VersionedObject, LA_Party, LA_GroupParty
Administrative Package			Exist only if Party Package is implemented
	LA_RRR	1	VersionedObject, Oid, LA_Party, LA_BAUnit, LA_Right (as a minimum, this specialization shall be implemented), LA_AdministrativeSource
	LA_Right	1	LA_RRR, LA_RightType
	LA_Restriction	2	LA_RRR, LA_RestrictionType
	LA_Responsibility	3	LA_RRR, LA_ResponsibilityType
	LA_BAUnit	1	VersionedObject, Oid, LA_RRR, LA_BAUnitType
	LA_Mortgage	2	LA_Restriction
	LA_AdministrativeSource	1	LA_Source, LA_Party, LA_AdministrativeSourceType, LA_AvailabilityStatusType
	LA_RequiredRelationshipBAUnit	3	VersionedObject, LA_BAUnit
Spatial Unit Package			
	LA_SpatialUnit	1	VersionedObject, Oid
	LA_SpatialUnitGroup	2	VersionedObject, Oid, LA_SpatialUnit
	LA_LegalSpaceBuildingUnit	3	LA_SpatialUnit
	LA_LegalSpaceUtilityNetwork	3	LA_SpatialUnit
	LA_Level	2	VersionedObject, Oid
	LA_RequiredRelationshipSpatialUnit	3	VersionedObject, LA_SpatialUnit
Surveying and Representation Subpackage			
	LA_Point	2	VersionedObject, Oid, LA_SpatialSource, LA_PointType, LA_InterpolationType
	LA_SpatialSource	2	LA_Source, LA_Point, LA_Party, LA_SpatialSourceType
	LA_BoundaryFaceString	2	VersionedObject, Oid, LA_Point (if using geometry)
	LA_BoundaryFace	3	VersionedObject, Oid, LA_Point (if using geometry)

[a] CI = Conformance level.

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 one of the basic classes of the LADM. The implementation class shall conform to basic class. This means that a LADM package is level 1 compliant if:

— Party Package: test A.2.4 is passed successfully;

— Administrative Package: test A.2.3 and test A.2.5 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), and/or

— Spatial Unit Package: test A.2.6 is passed successfully.

A.2.2 Test case identifier: VersionedObject

a) Test Purpose: if VersionedObject is implemented, to ensure that the implementation package under test contains at least one class conformant with the definition of VersionedObject and which has all mandatory attributes and association roles of VersionedObject.

NOTE Mandatory attributes or associations have occurrence (multiplicity) 1 or higher.

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

c) Reference: level 1 requirement, see 6.2.1.

d) Test Type: Basic.

A.2.3 Test case identifier: Administrative::LA_BAUnit

a) Test Purpose: if LA_BAUnit is implemented, to ensure that the implementation package under test contains at least one class conformant with the 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 the implementation under test, including class, attribute(s) and association definitions.

c) Reference: level 1 requirement, see 6.4.1.

d) Test Type: Basic.

A.2.4 Test case identifier: Party::LA_Party

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

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

c) Reference: level 1 requirement, see 6.3.1.

d) Test Type: Basic.

A.2.5 Test case identifier: Administrative::LA_Right

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

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

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

d) Test Type: Basic.

A.2.6 Test case identifier: Spatial Unit::LA_SpatialUnit

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

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

c) Reference: level 1 requirement, see 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 basic class(es) and the more common classes of the LADM. These classes of the LADM are, in addition to the basic classes (level 1): LA_AdministrativeSource, LA_BoundaryFaceString, LA_GroupParty, LA_PartyMember, LA_Point, LA_Restriction, LA_SpatialSource, and LA_SpatialUnitGroup. The implementation class shall conform to basic/common 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;

  — Surveying and Representation subpackage: test A.3.3, test A.3.6 and test A.3.8 are passed successfully.

A.3.2 Test case identifier: Administrative::LA_AdministrativeSource

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

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

c) Reference: level 2 requirement, see 6.2.2 to 6.2.4.

d) Test Type: Basic.

A.3.3 Test case identifier: Surveying and Representation::LA_BoundaryFaceString

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

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

c) Reference: level 2 requirement, see 6.6.3.

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 the definition of LA_GroupParty and has all mandatory attributes and association roles of LA_GroupParty.

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

c) Reference: level 2 requirement, see 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 the definition of LA_PartyMember and has all mandatory attributes and association roles of LA_PartyMember.

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

c) Reference: level 2 requirement, see 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 the definition of LA_Point and which has all mandatory attributes and association roles of LA_Point.

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

c) Reference: level 2 requirement, see 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 the definition of LA_Restriction and has all mandatory attributes and association roles of LA_Restriction

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

c) Reference: level 2 requirement, see 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 the definition of LA_SpatialSource and has all mandatory attributes and association roles of LA_SpatialSource.

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

c) Reference: level 2 requirement, see 6.6.2.

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 the definition of LA_SpatialUnitGroup and has all mandatory attributes and association roles of LA_SpatialUnitGroup.

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

c) Reference: level 2 requirement, see 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 basic class(es) and all the other class(es) of the LADM. These classes of the LADM are, in addition to the basic and common classes (level 1 and 2): LA_BoundaryFace, LA_LegalSpaceBuildingUnit, LA_LegalSpaceUtilityNetwork, LA_Mortgage, LA_RequiredRelationshipSpatialUnit, and LA_Responsibility. The implementation class shall conform to basic and common 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: Surveying and Representation::LA_BoundaryFace

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

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

c) Reference: level 3 requirement, see 6.6.4.

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 the definition of LA_LegalSpaceBuildingUnit and has all mandatory attributes and association roles of LA_LegalSpaceBuildingUnit.

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

c) Reference: level 3 requirement, see 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 the definition of LA_LegalSpaceUtilityNetwork and has all attributes and association roles of LA_LegalSpaceUtilityNetwork.

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

c) Reference: level 3 requirement, see 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 the definition of LA_Mortgage and has all mandatory attributes and association roles of LA_Mortgage.

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

c) Reference: level 3 requirement, see 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 the definition of LA_RequiredRelationshipSpatialUnit and has all mandatory attributes and association roles of LA_RequiredRelationshipSpatialUnit.

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

c) Reference: level 3 requirement, see 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 the definition of LA_Responsibility and has all attributes and roles of LA_Responsibility.

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

c) Reference: level 3 requirement, see 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) For 2D boundary representations, by boundary face strings using a GM_MultiCurve (linestring) for storage. Boundary face strings also imply a series of vertical virtual boundary faces, see Figures B.1 and B.2.

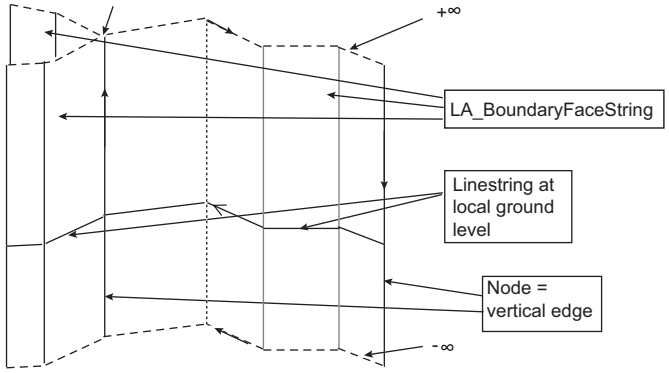


Figure B.1 — Boundary face string concepts

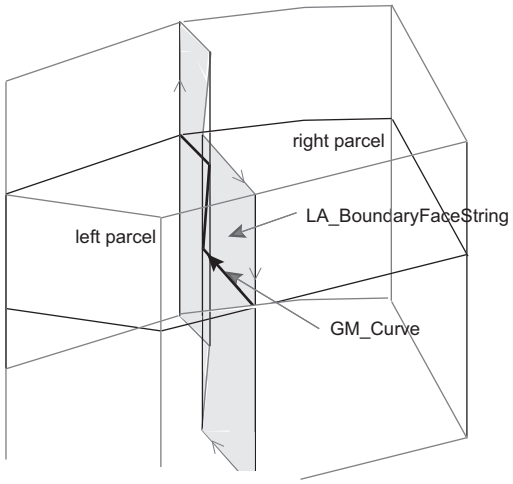


Figure B.2 — Spatial units defined by boundary face strings

b) For true 3D boundary representations, by boundary faces using 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.

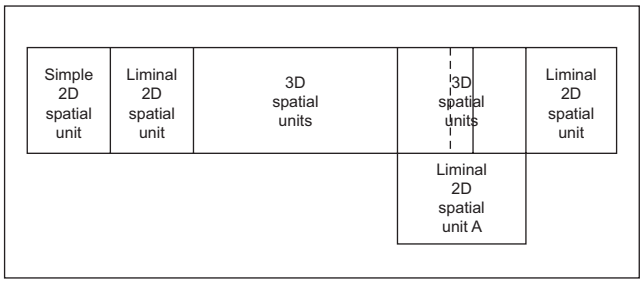


Figure B.3 — Top view of mixed 2D/3D representations

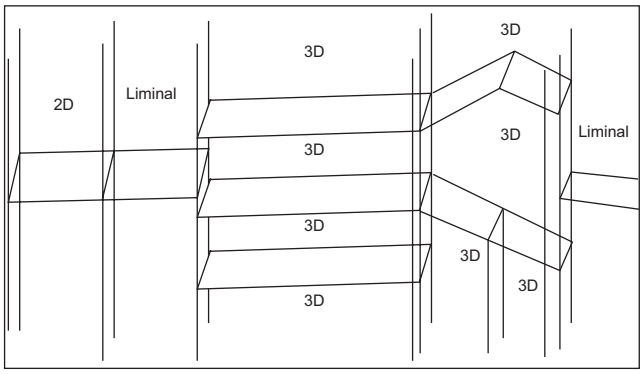


Figure B.4 — Side view showing the mixed use of boundary face strings and boundary faces to define both bounded and unbounded 3D volumes

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

Annex C
(informative)

Instance level cases

This Annex illustrates the flexibility and functionality of this International Standard, by showing its use in real world 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) Longlease (Figure C.1).

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

2) Customary right (Figure C.2).

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

3) Serving parcel – owned by neighbours (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).

4) Serving parcel – owned by a separate 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.

5) Group party (Figure C.5).

   A group party holds an ownership right on a parcel. The group party is composed out of three parties.

6) Apartment building (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.

7) 3D spatial unit (Figure C.7).

   A 3D volume spatial unit with one owner.

8) Timeshare ownership (Figure C.8).

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

9) Restriction (Figure C.9).

   A restriction not to change a building because of its status as a monument.

10) Mortgage on ownership (Figure C.10).

    Mortgage on ownership, bank included as party.

11) Mortgage on usufruct ownership (Figure C.11).

    Mortgage on usufruct ownership, money provider included as party.

12) Informal right – text spatial unit (Figure C.12).

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

13) Informal right – point spatial unit (Figure C.13).

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

14) Conflict (Figure C.14).

    A conflicting claim on a spatial unit.

15) Utility network (Figure C.15).

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

16) Pastoralists (Figure C.16).

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

17) Basic property unit – Finland (Figure C.17).

    A simple case of owning a basic property unit with several spatial units.

18) Value (Figure C.18).

    Value as a basis for taxation valid for five years (note that valuation and taxation are outside the scope of the LADM).

19) Milk right (Figure C.19).

    A milk right to a spatial unit.

20) Responsibility (Figure C.20).

    A responsibility to clean the ditches.

21) Right to use (I) (Figure C.21).

    A right to use a road on somebody else's property (I).

22) Right to use (II) (Figure C.22).

    A right to use a road on somebody else's property (II).

23) A restriction area (Figure C.23).

    A restriction area ("it is not allowed to build within 200 metres of a fuel station") with its own geometry.

24) Spatial unit complex (I) (Figure C.24).

    Spatial unit complex with one owner.

25) Spatial unit complex (II) (Figure C.25).

    Spatial unit complex with building, from a single owner (Aurora).

26) Spatial unit complex (III) (Figure C.26).

    Spatial unit complex of parcels with two owners.

27) Micro credit (Figure C.27).

    Spatial unit with micro credit.

28) Tax valuations – Spain (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.

29) Building ownership (Figure C.29).

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

30) Marriage and inheritance (I) – Spain (Figure C.30).

    Marriage and inheritance relationships to property (simple) in Spain. A married couple owns a property with equal shares.

31) Marriage and inheritance (II) – Spain (Figure C.31).

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

32) Real estate – Spain (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.

33) Basic property units (I) – Norway (Figure C.33).

    Norwegian categories of basic property units. Examples for Volume Unit, Landed Property and Leased Land Unit.

34) Basic property units (II) – Norway (Figure C.34).

    Norwegian categories of basic property units. Examples for a Co-Ownership Unit and a Section Unit.

35) Individual and joint property – Spain (Figure C.35).

    Individual and joint property rights in Spain. 'Corona' is the building name.

36) Grazing rights of pastoralists – Kenya (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.

37) Customary rights – Ghana (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).

38) Subdivision (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.

39) Buying and selling of a spatial unit (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.

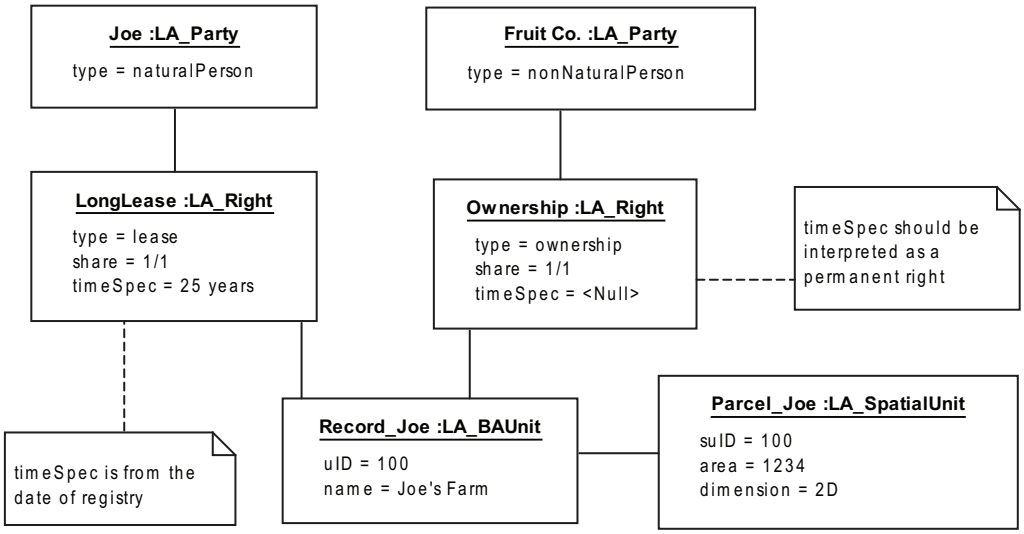


Figure C.1 — Longlease

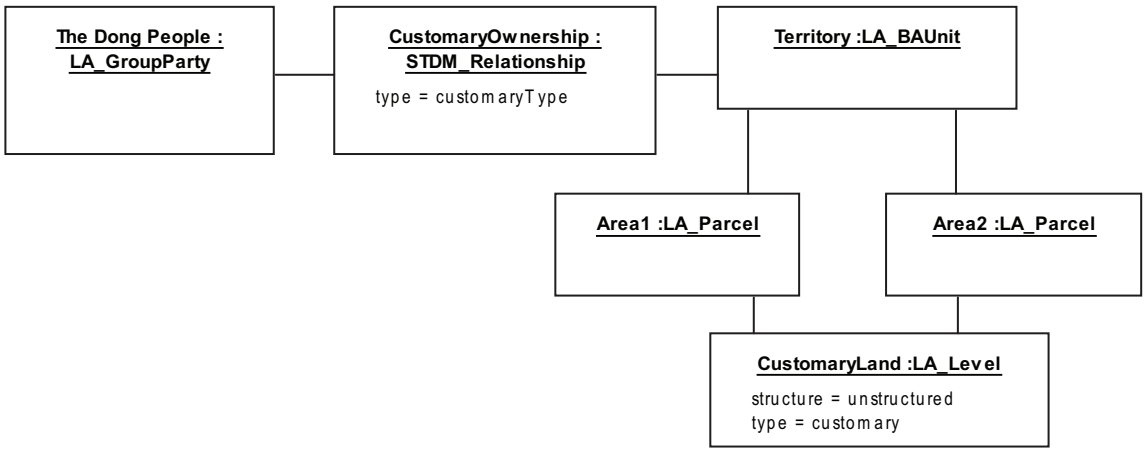


Figure C.2 — Customary right

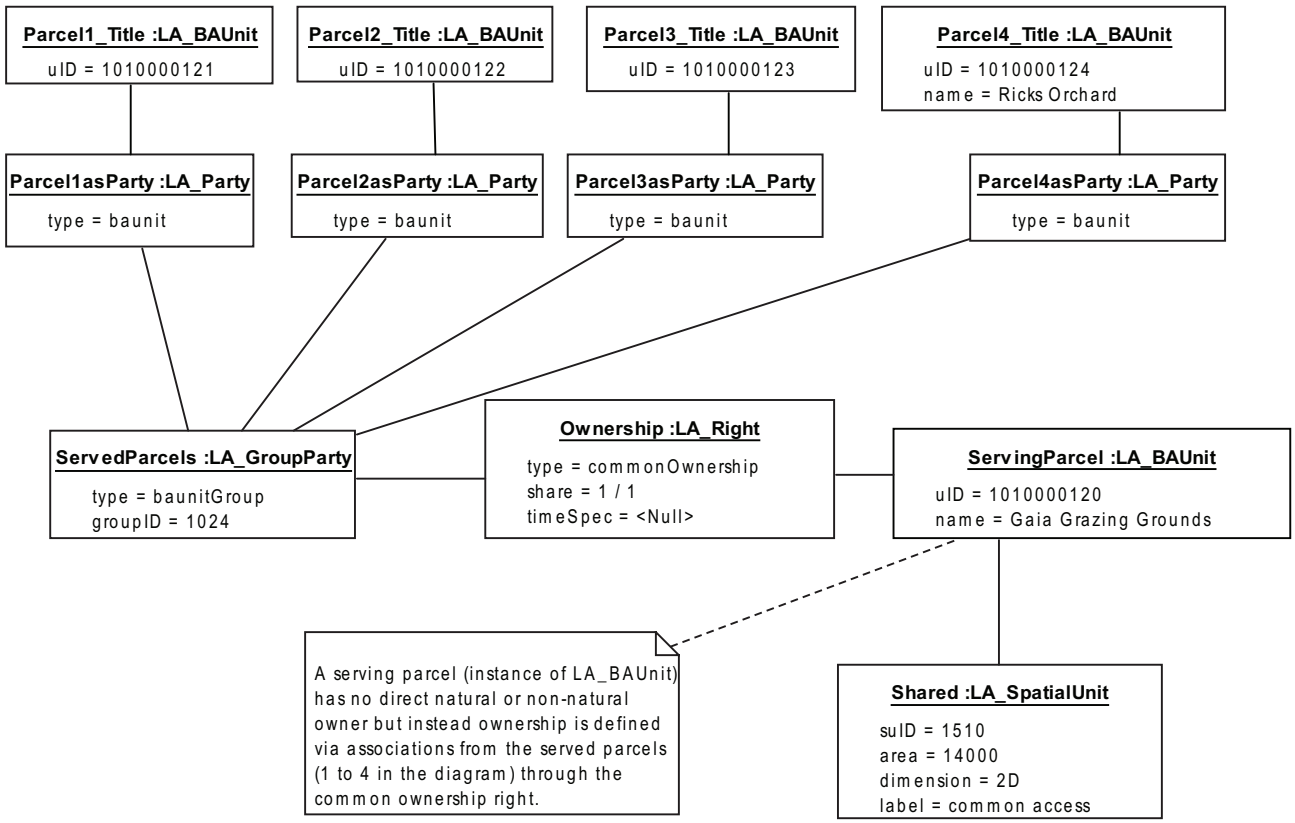


Figure C.3 — Serving parcel – owned by neighbours

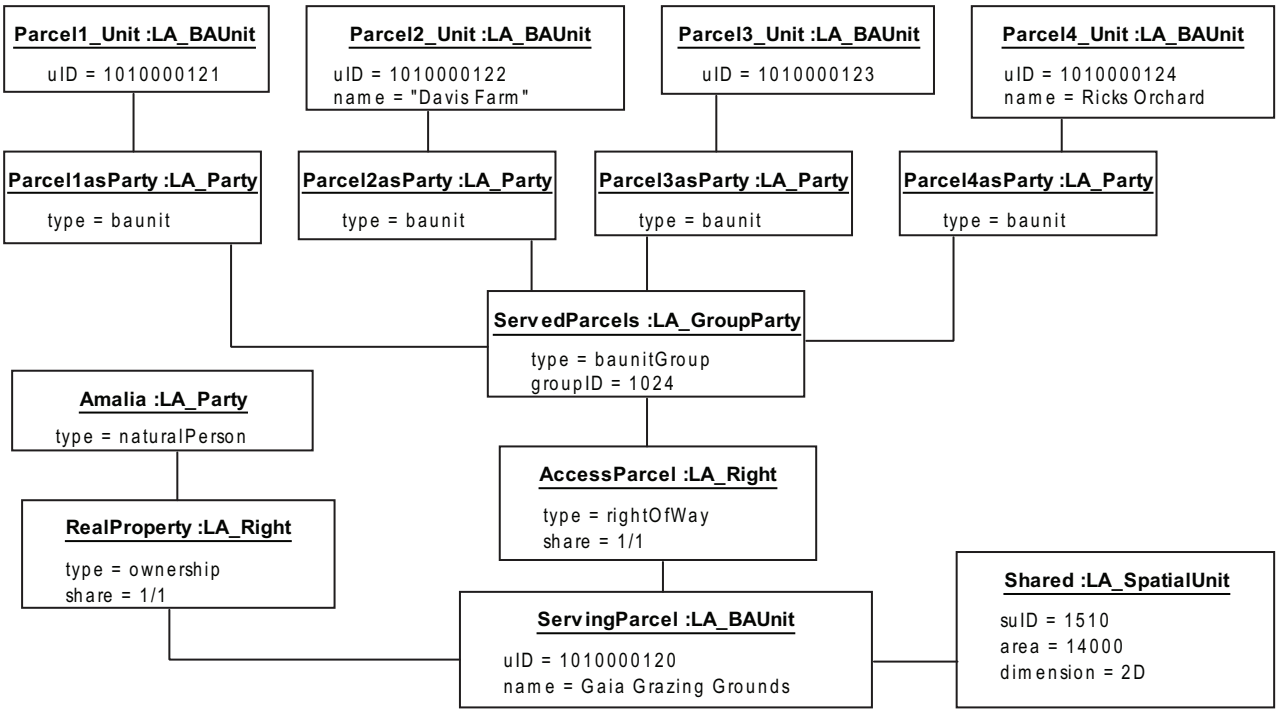


Figure C.4 — Serving parcel – owned by a separate party

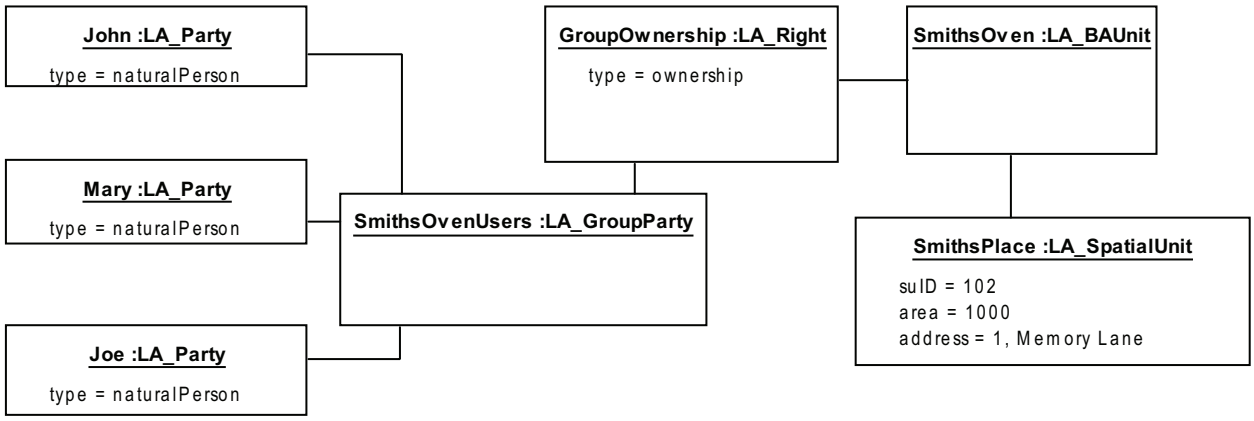


Figure C.5 — Group party

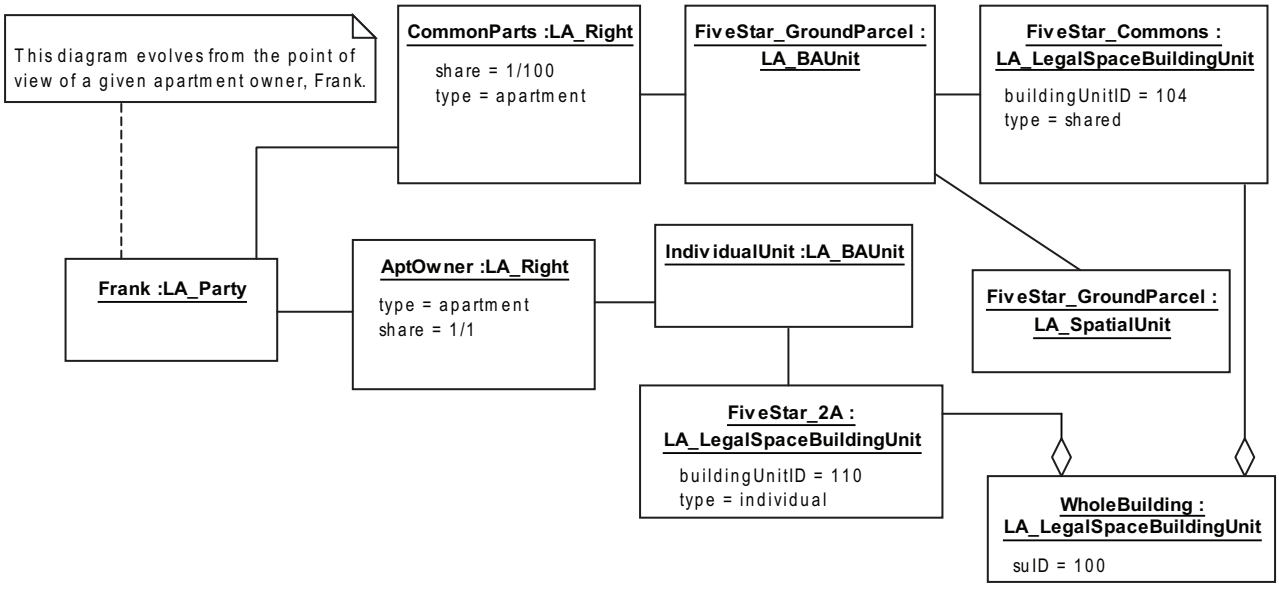


Figure C.6 — Apartment building

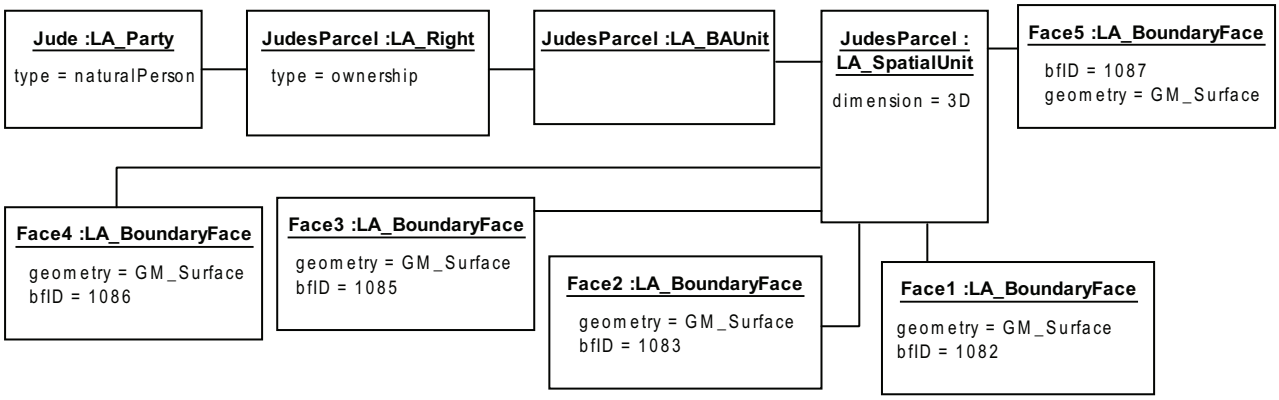


Figure C.7 — 3D spatial unit

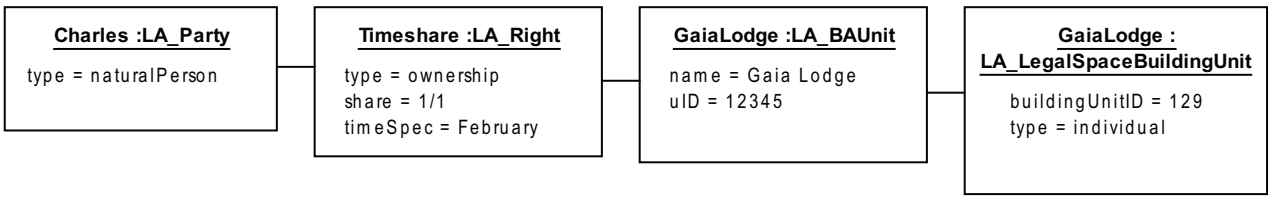


Figure C.8 — Timeshare ownership

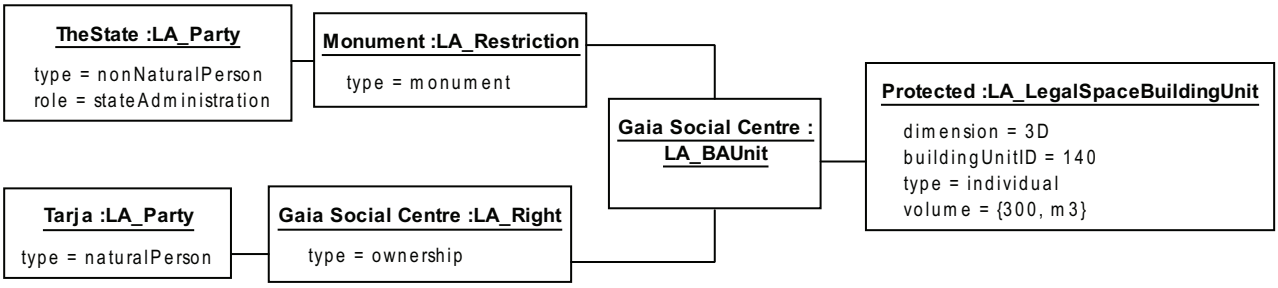


Figure C.9 — Restriction

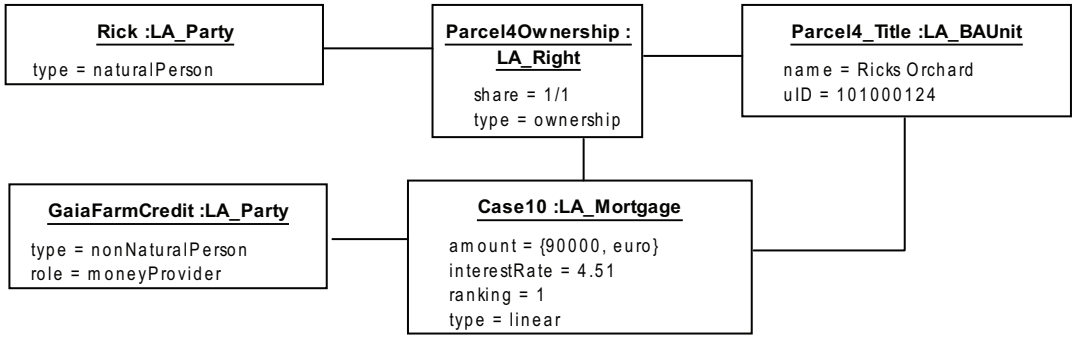


Figure C.10 — Mortgage on ownership

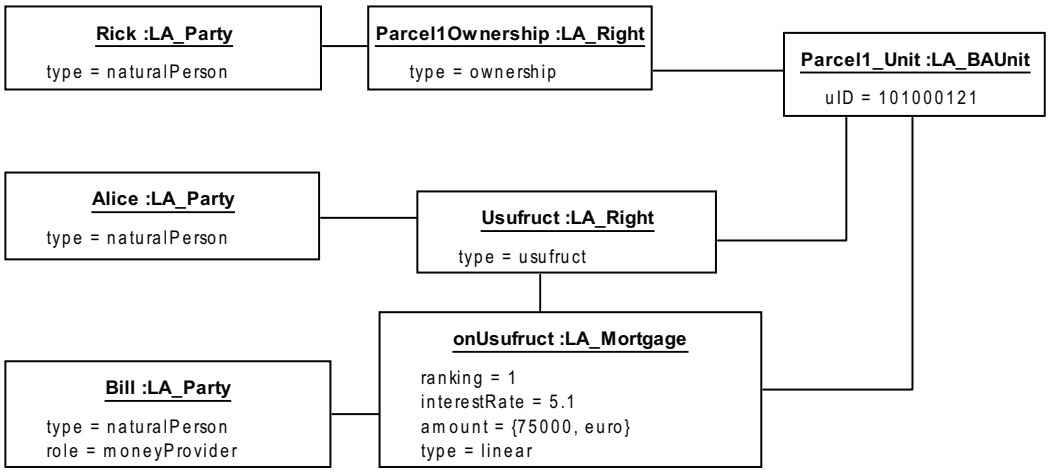


Figure C.11 — Mortgage on usufruct ownership

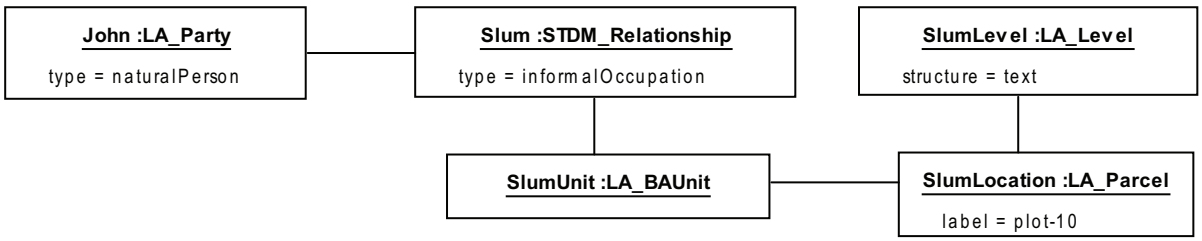


Figure C.12 — Informal right – text spatial unit

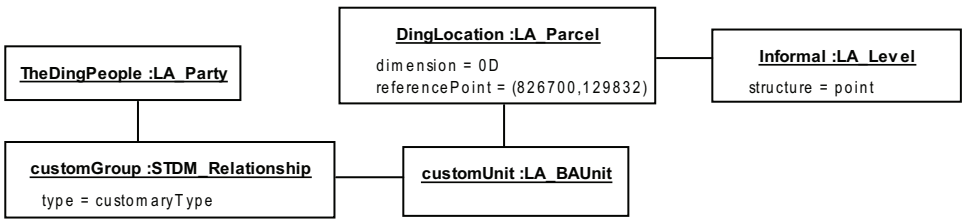


Figure C.13 — Informal right – point spatial unit

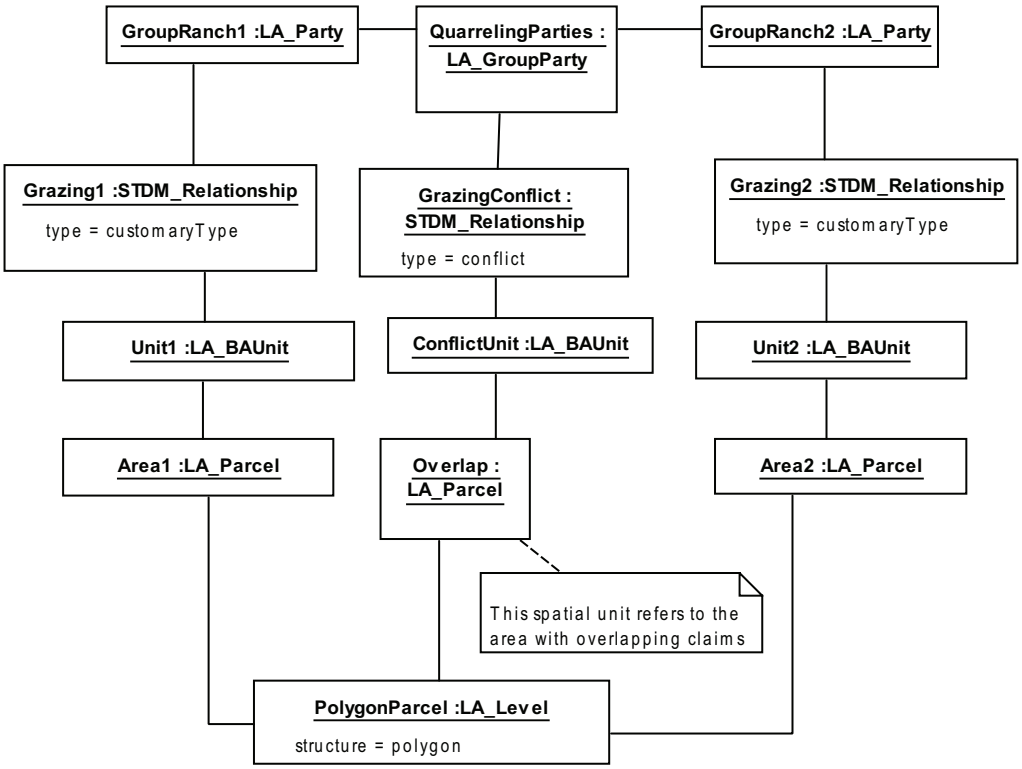


Figure C.14 — Conflict

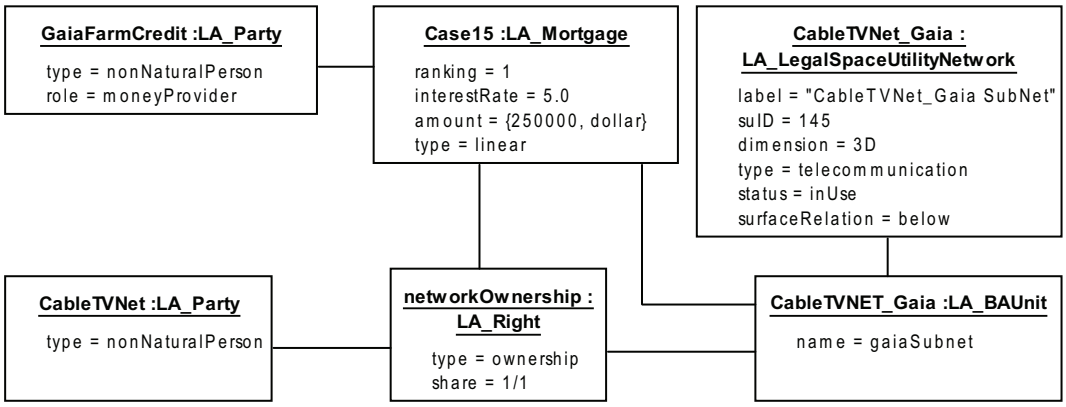


Figure C.15 — Utility network

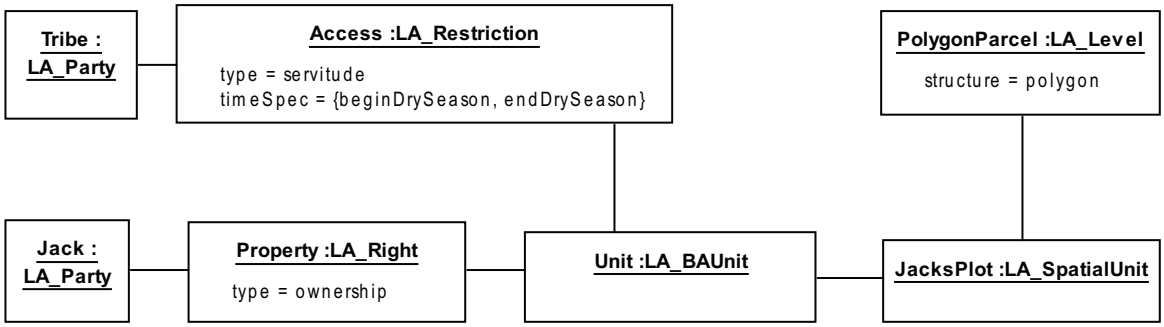


Figure C.16 — Pastoralists

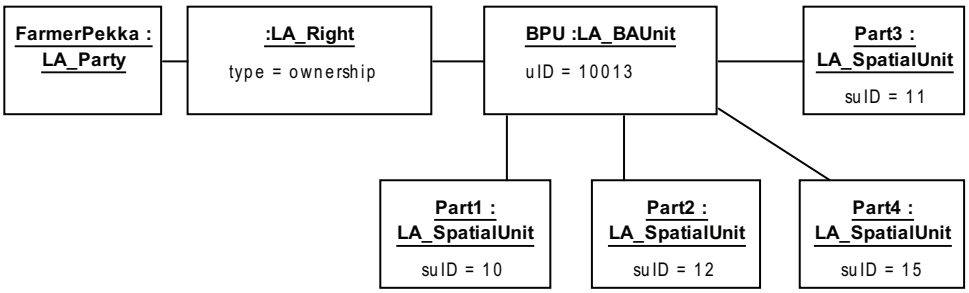


Figure C.17 — Basic property unit – Finland

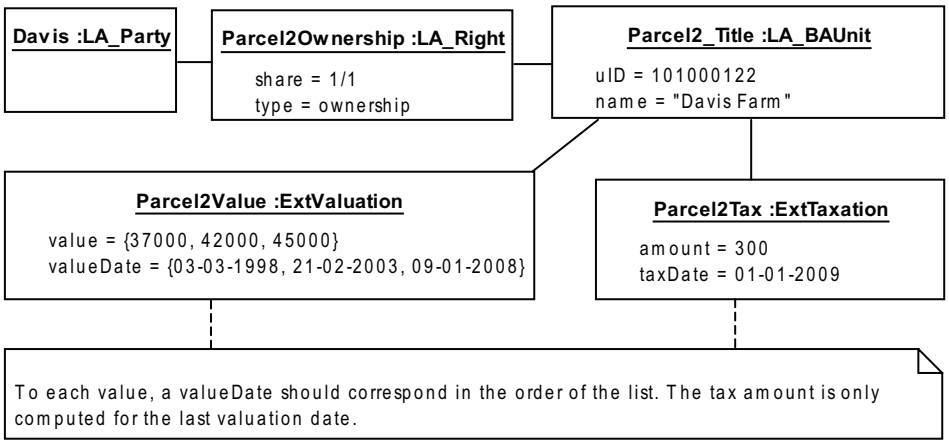


Figure C.18 — Value

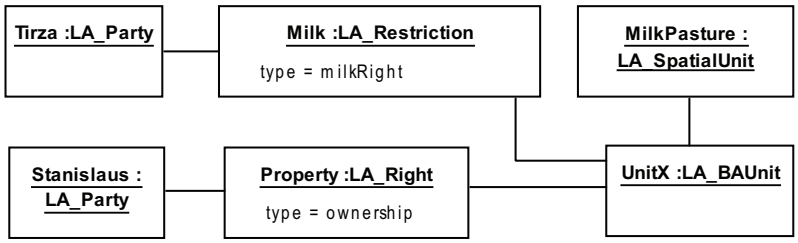


Figure C.19 — Milk right

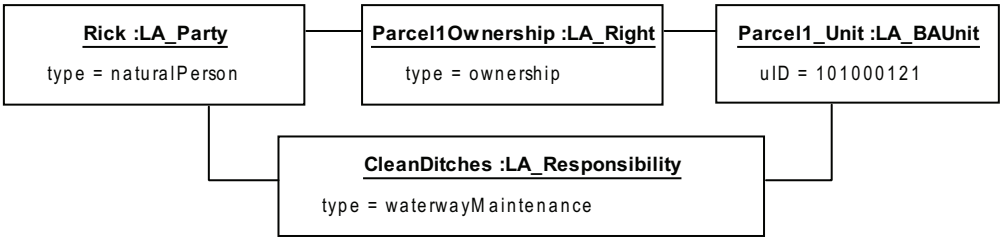


Figure C.20 — Responsibility

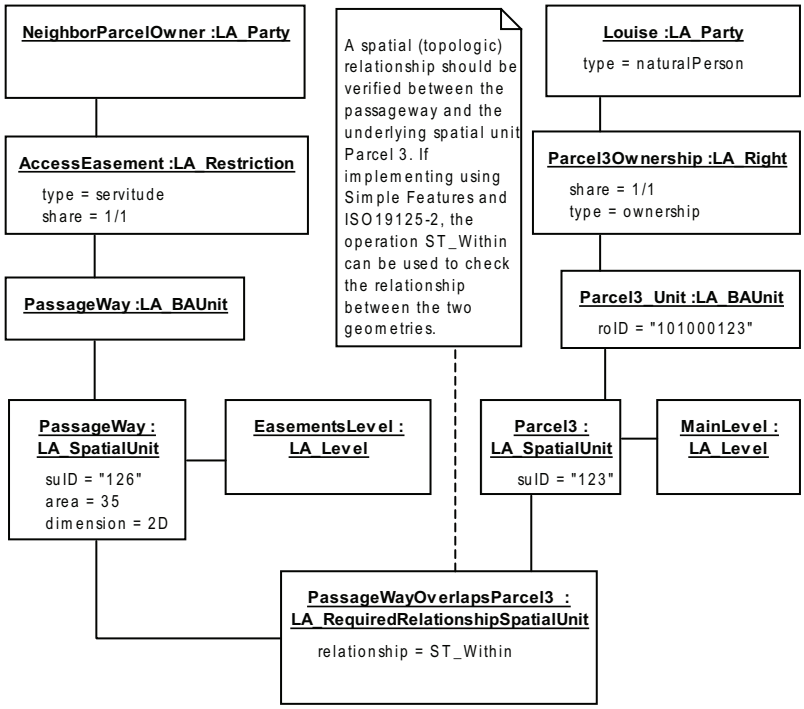


Figure C.21 — Right to use (I)

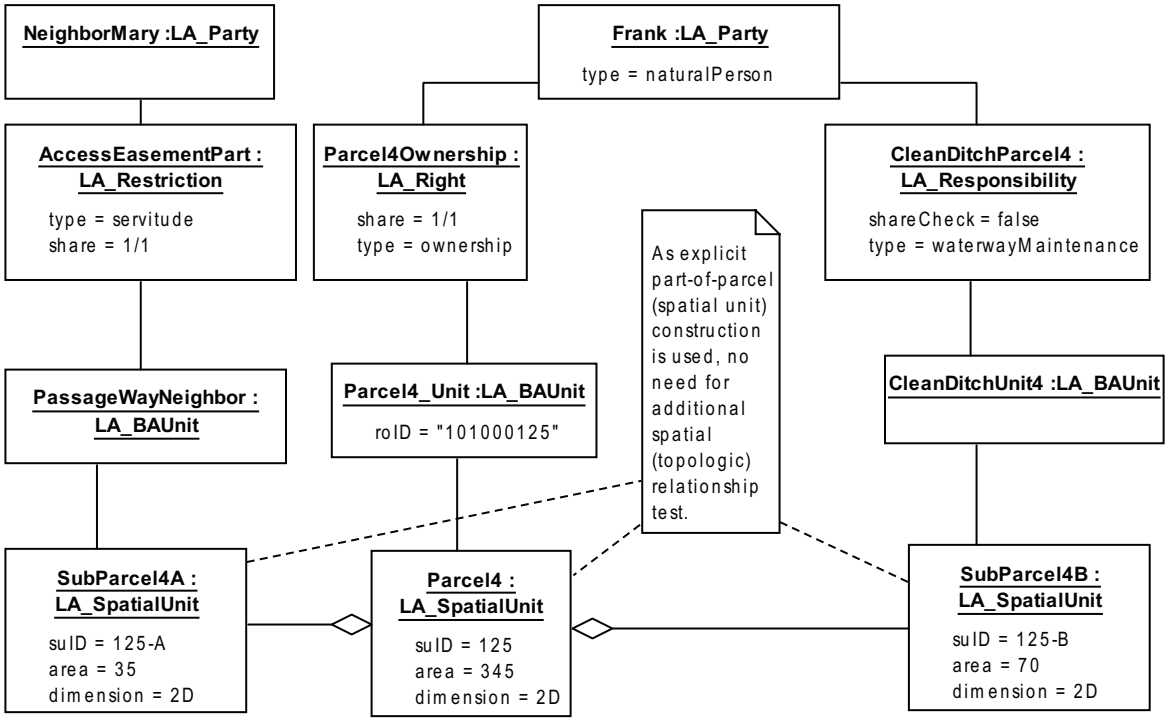


Figure C.22 — Right to use (II)

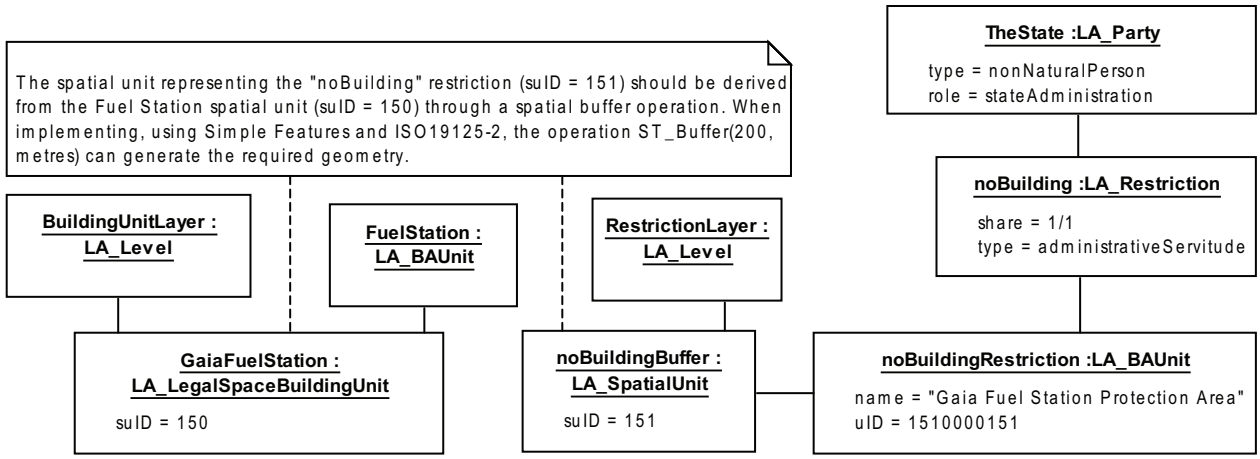


Figure C.23 — A restriction area

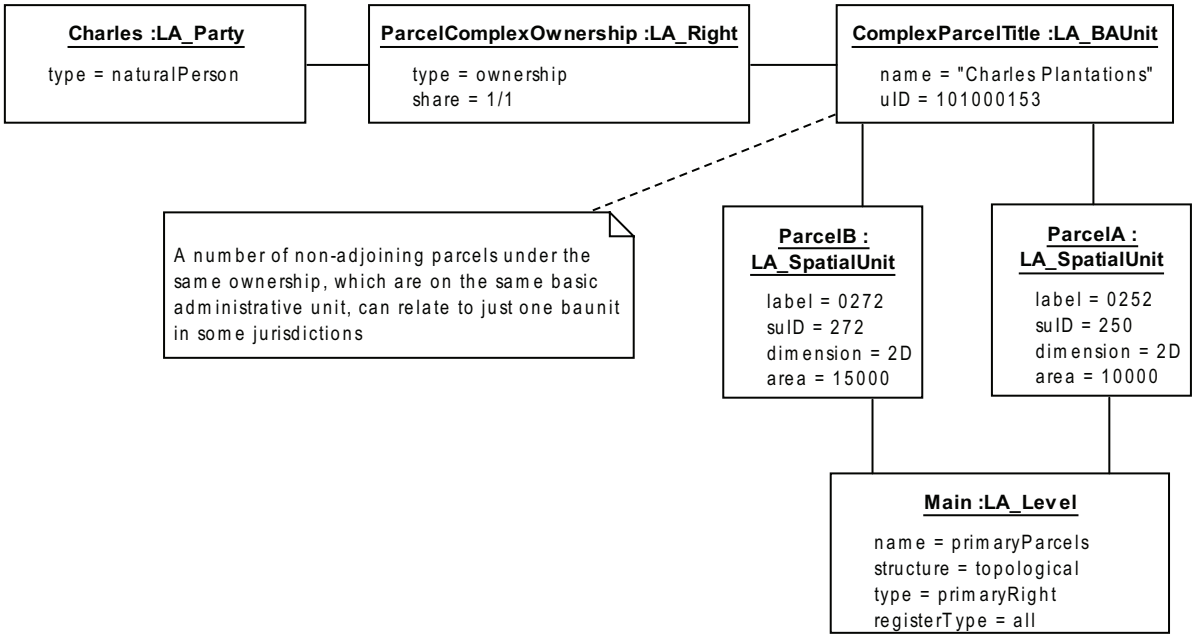


Figure C.24 — Spatial unit complex (I)

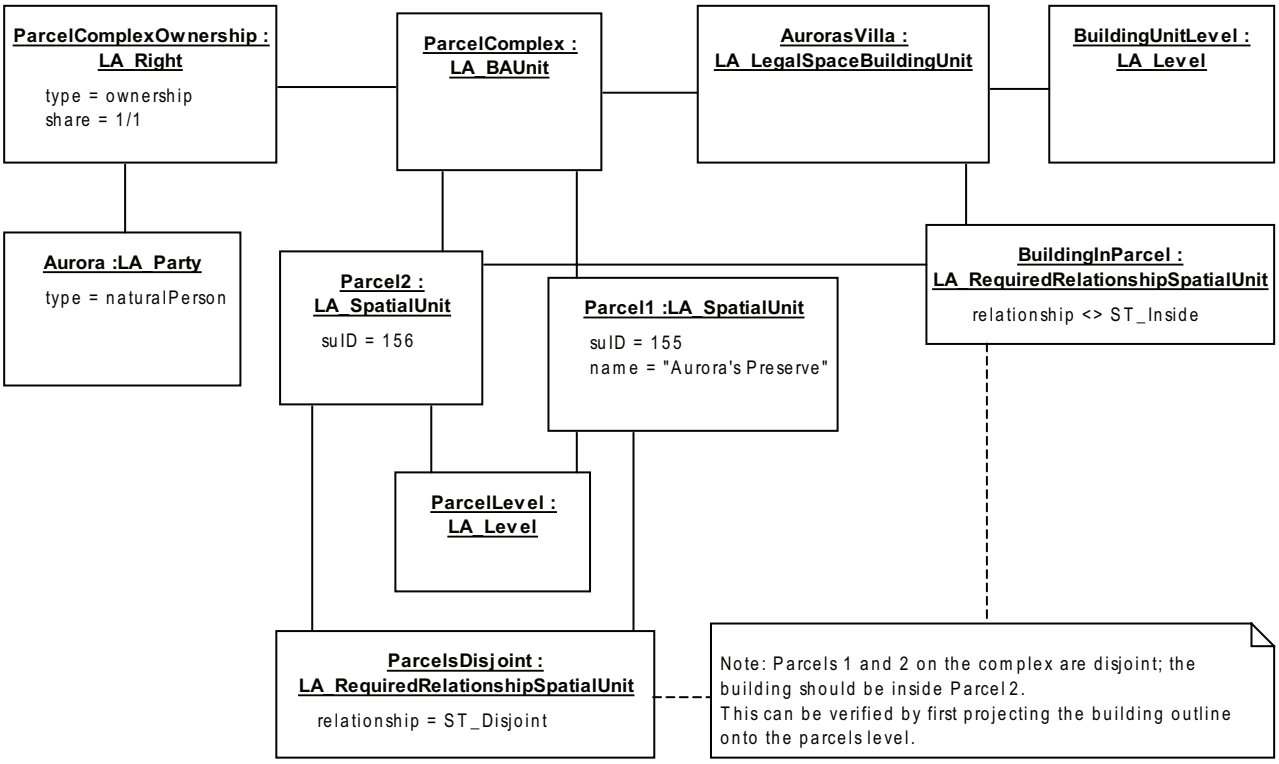


Figure C.25 — Spatial unit complex (II)

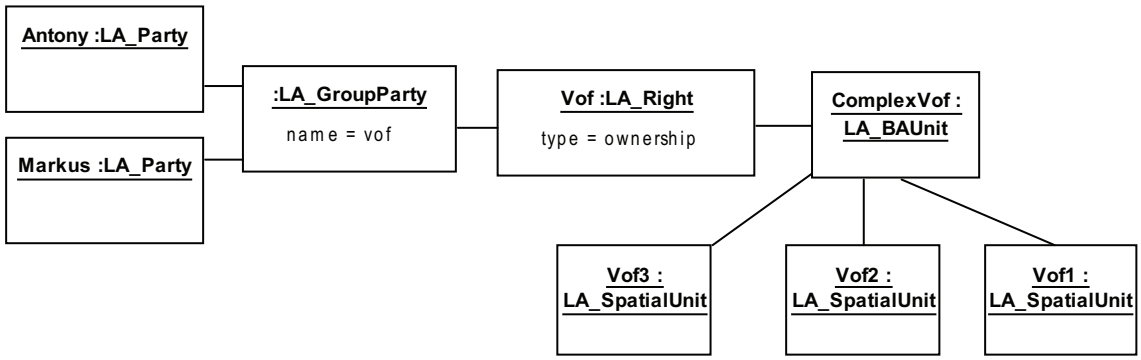


Figure C.26 — Spatial unit complex (III)

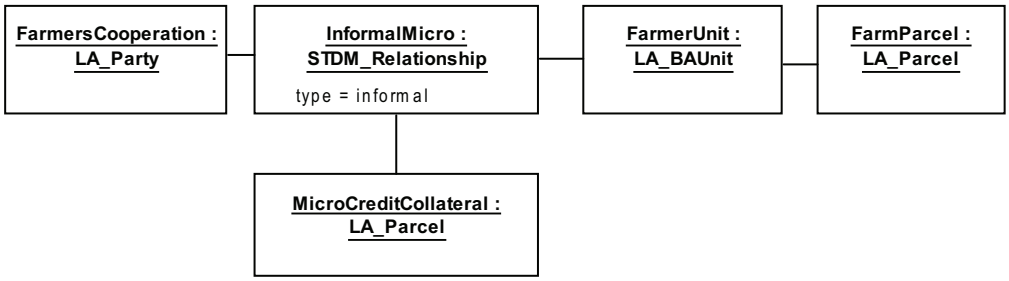


Figure C.27 — Micro credit

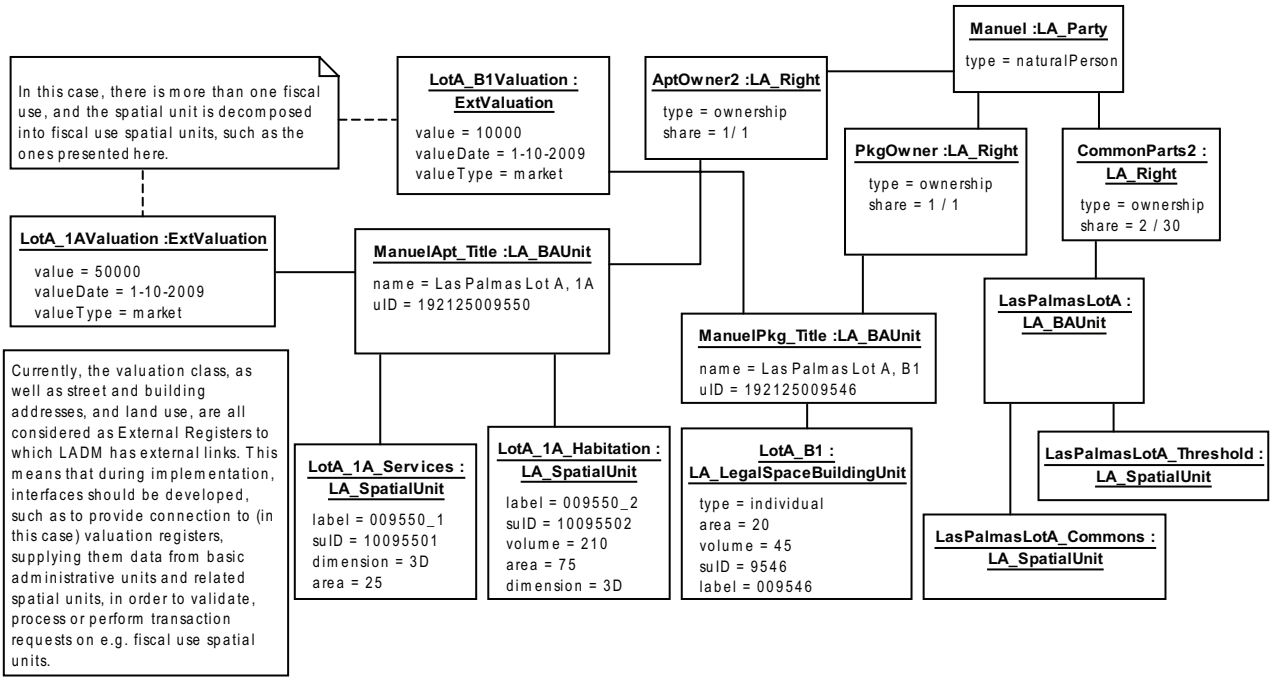


Figure C.28 — Tax valuations – Spain

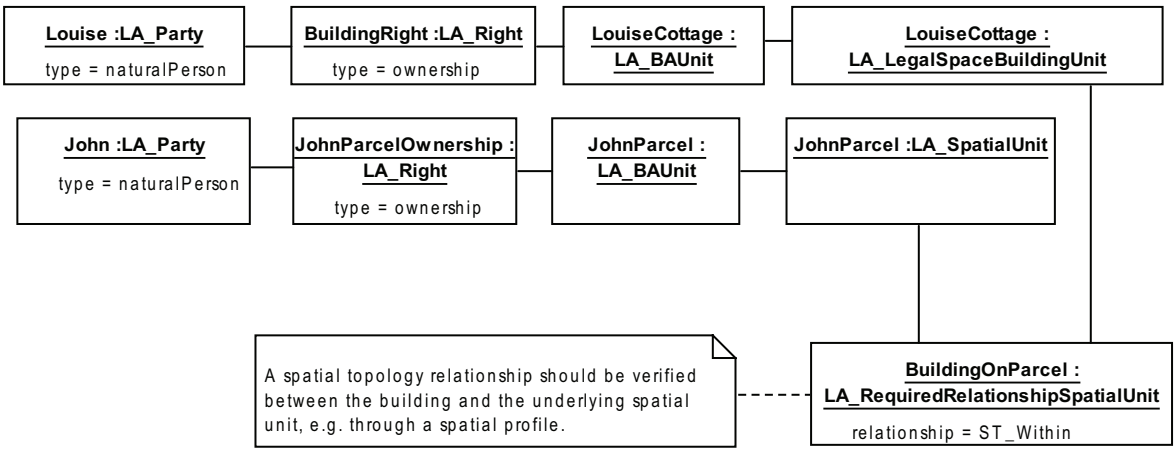


Figure C.29 — Building ownership

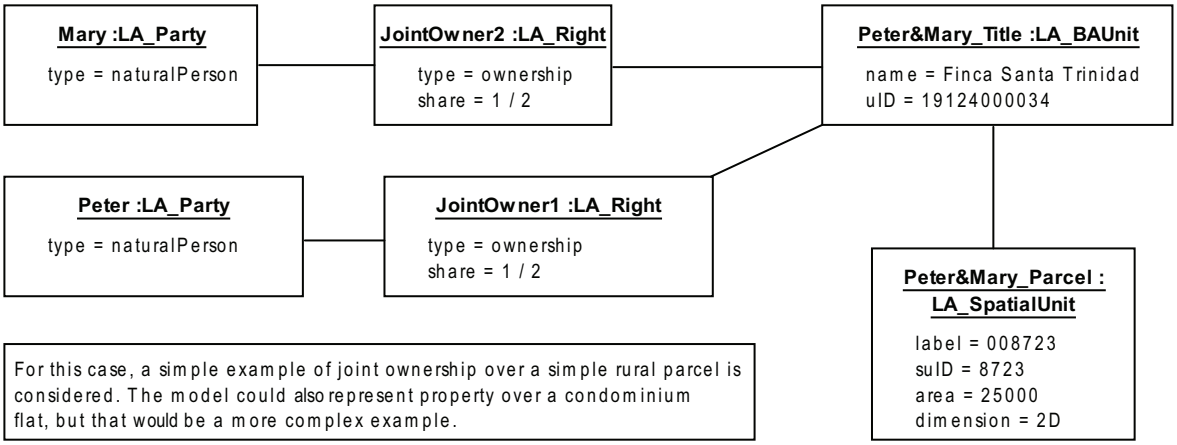
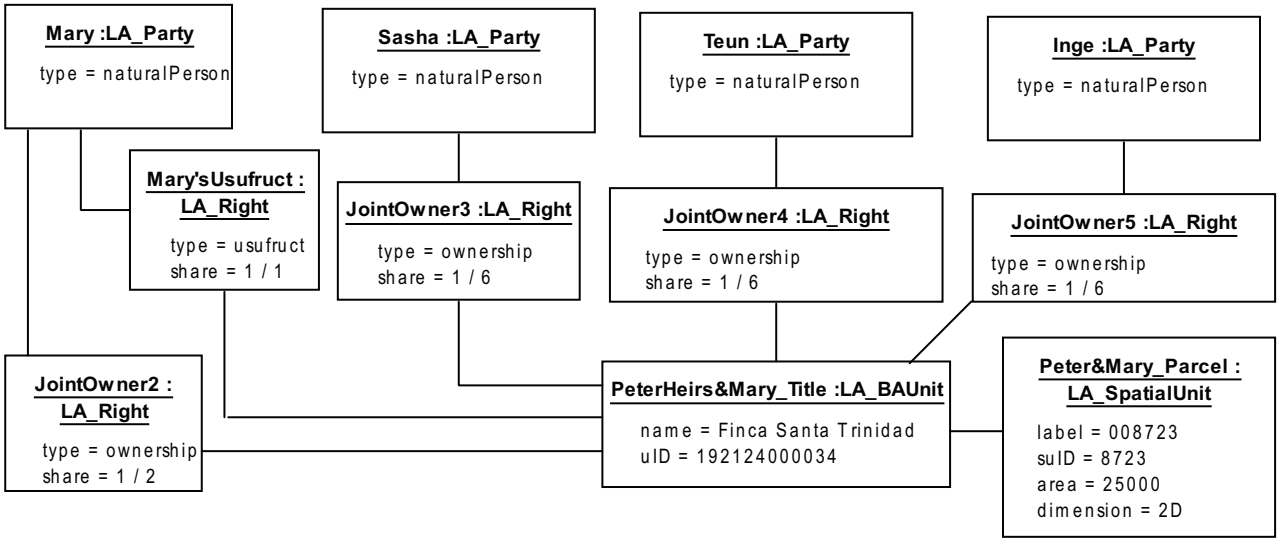


Figure C.30 — Marriage and inheritance (I) – Spain



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 (II) – Spain

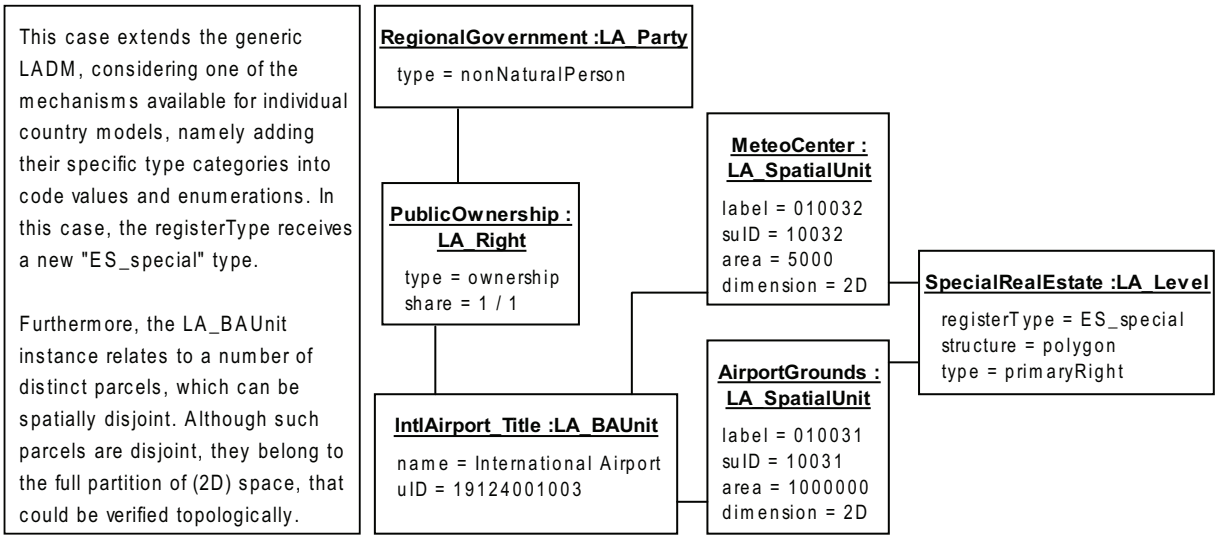


Figure C.32 — Real estate – Spain

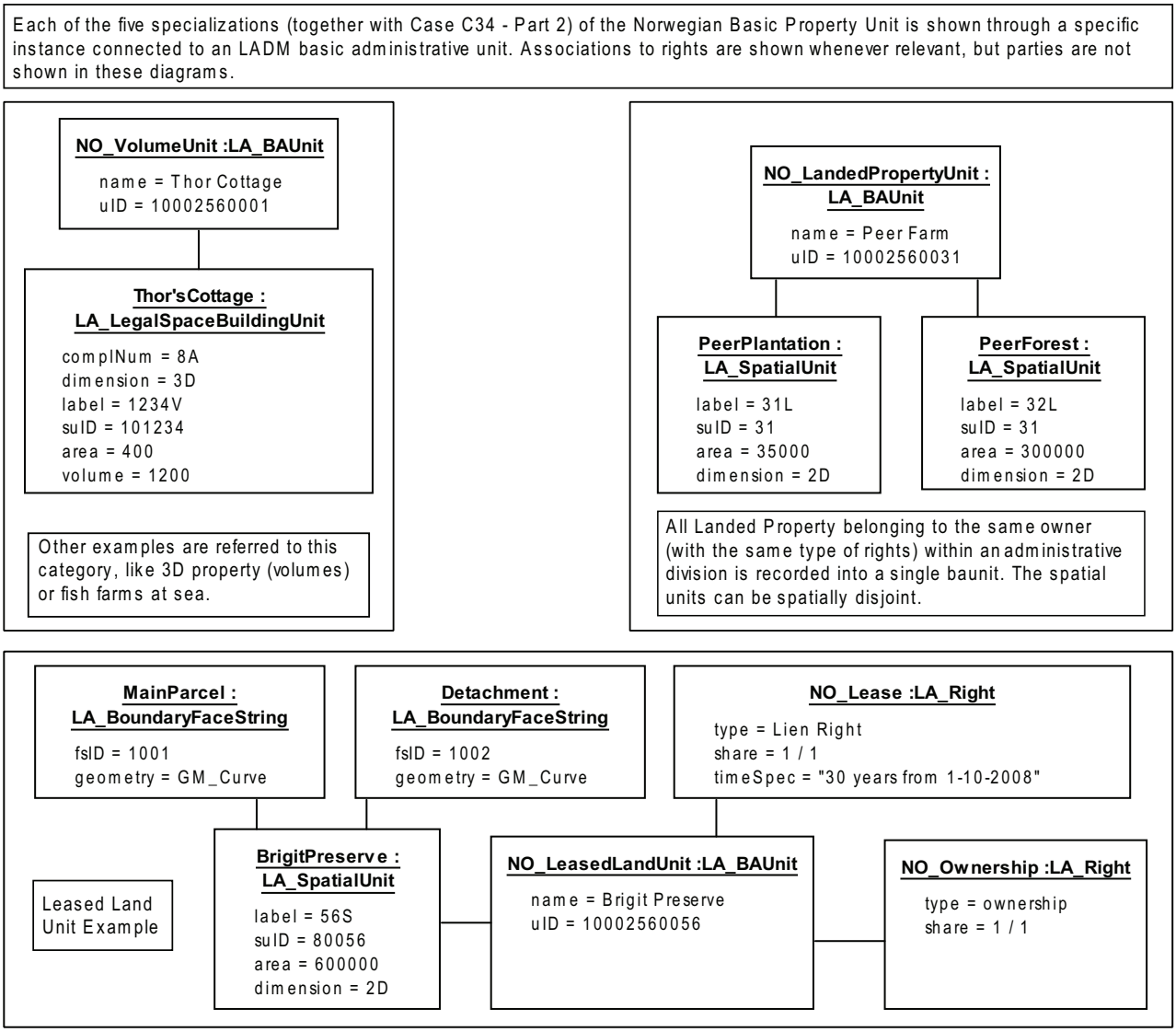


Figure C.33 — Basic property units (I) – Norway

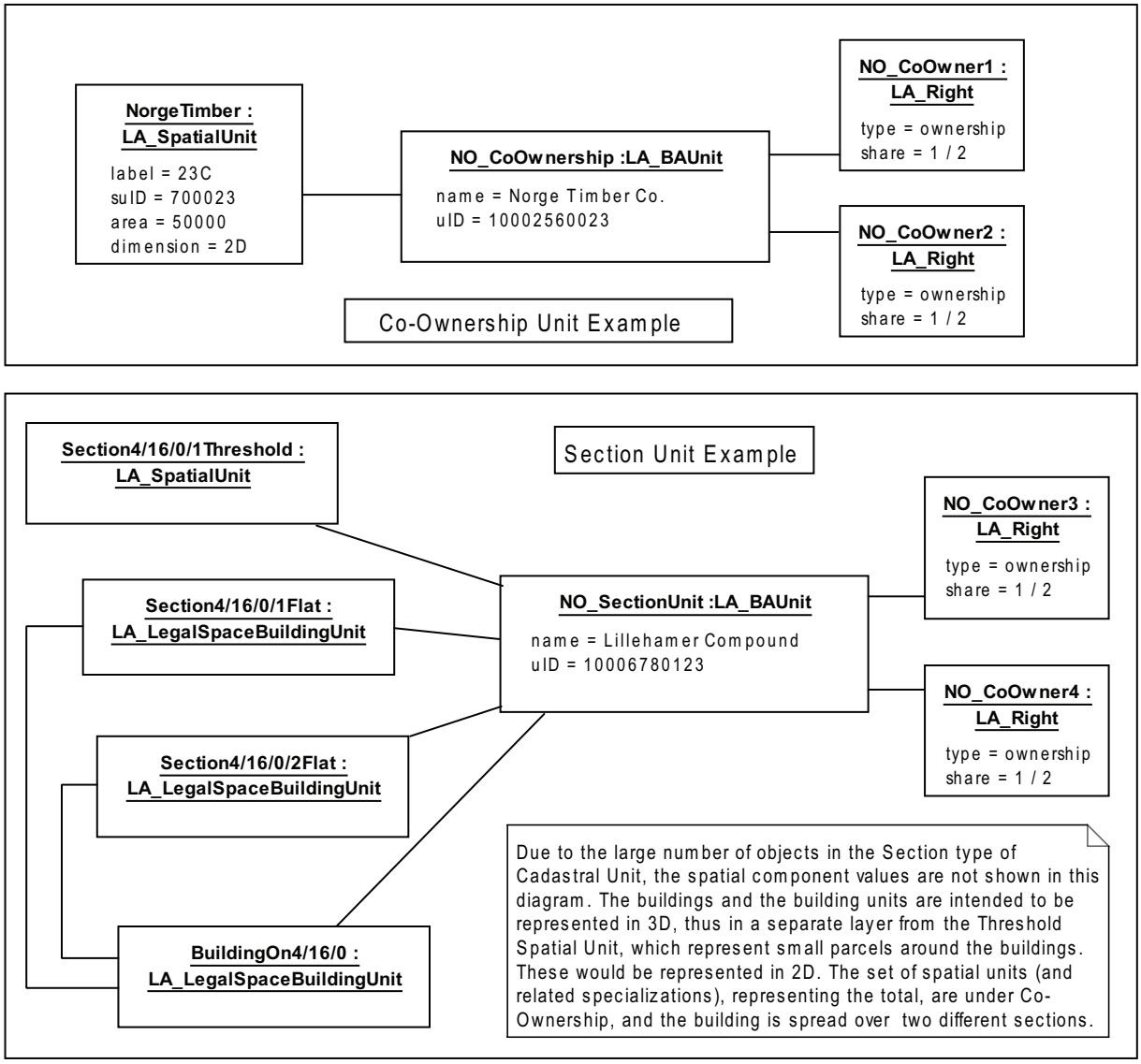


Figure C.34 — Basic property units (II) – Norway

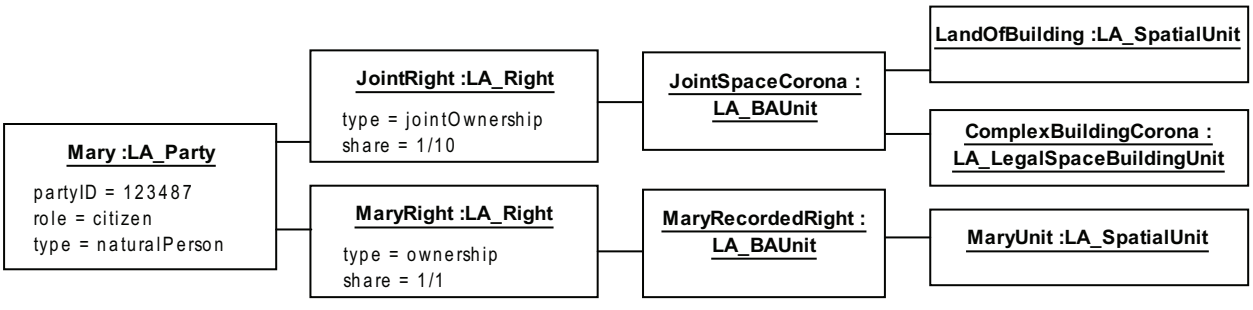


Figure C.35 — Individual and joint property – Spain

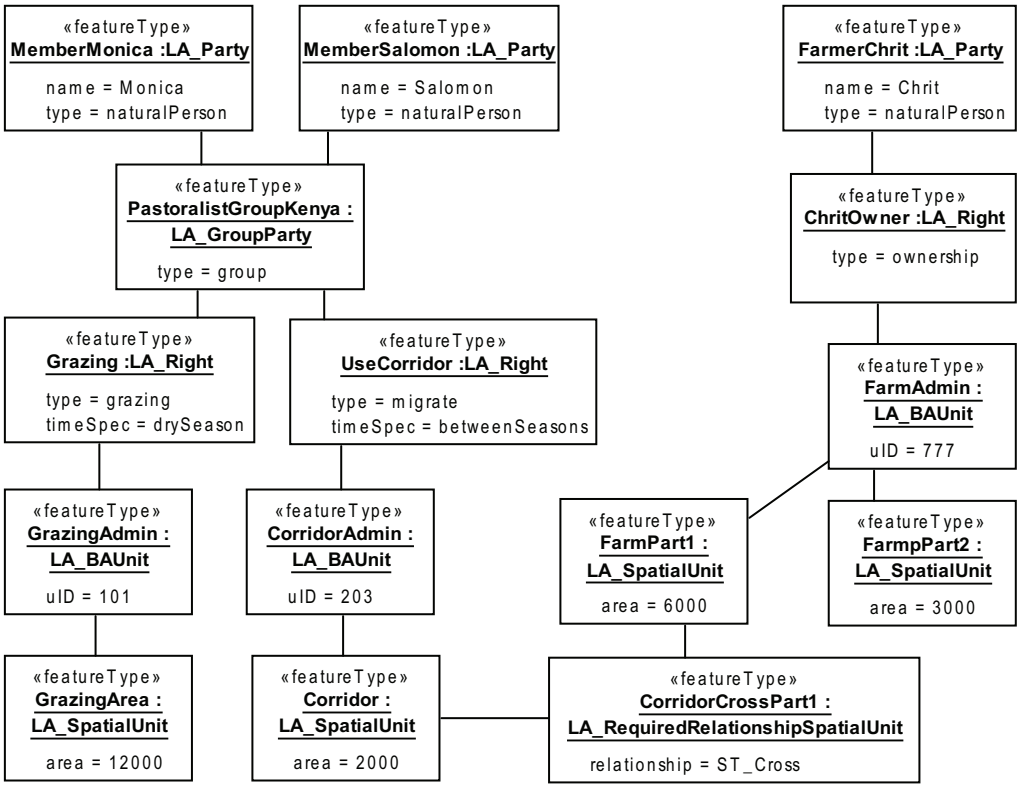


Figure C.36 — Grazing rights of pastoralists – Kenya

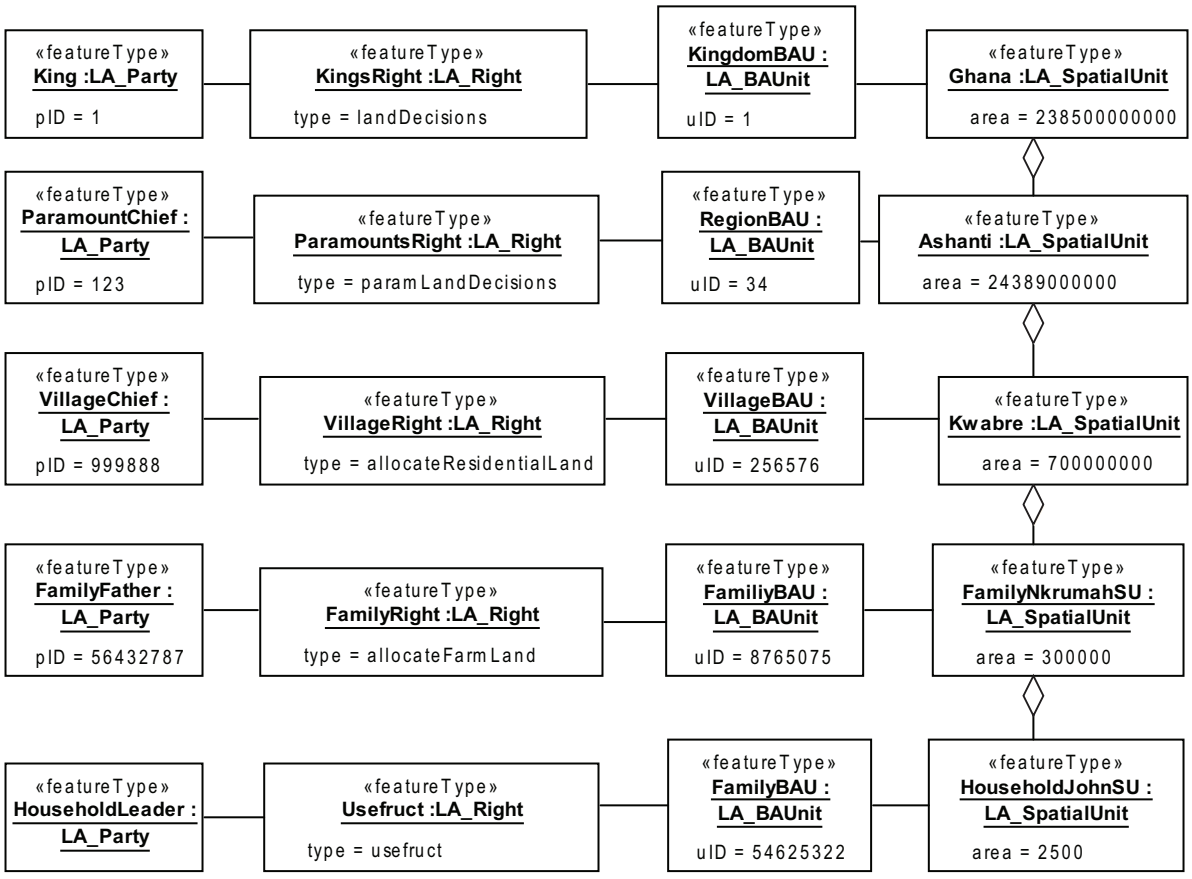


Figure C.37 — Customary rights – Ghana

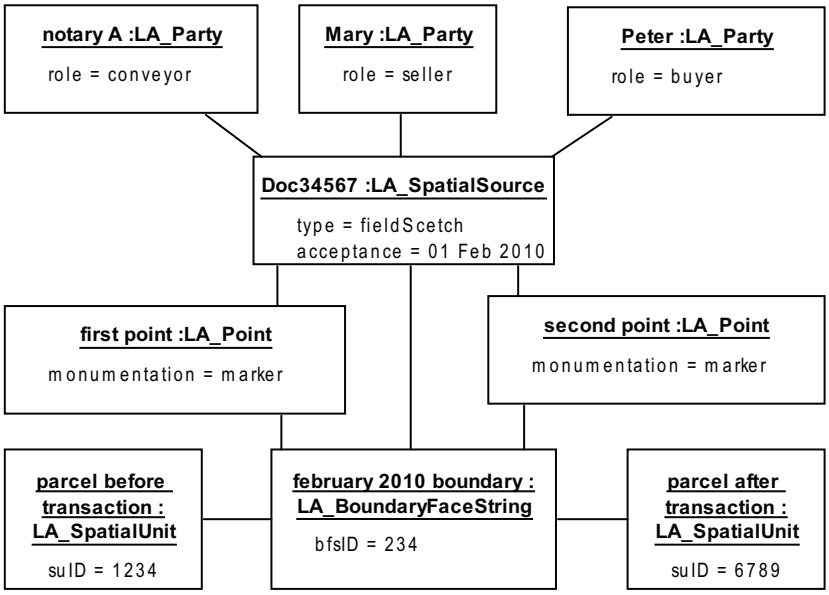


Figure C.38 — Subdivision

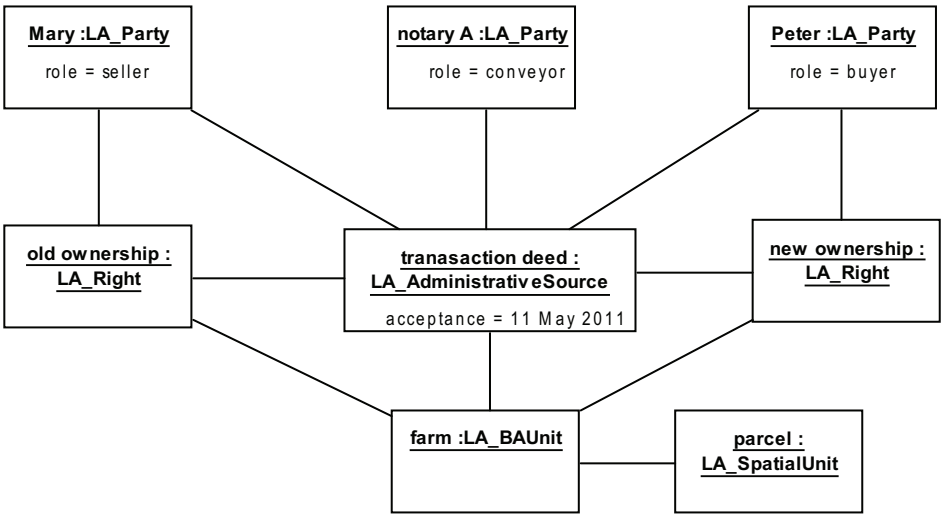


Figure C.39 — Buying and selling of a spatial unit

Annex D
(informative)

Country profiles

In this Annex eight country profiles of the 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).
7) Russian Federation (Figure D.8).
8) Republic of Korea (Figure D.9).

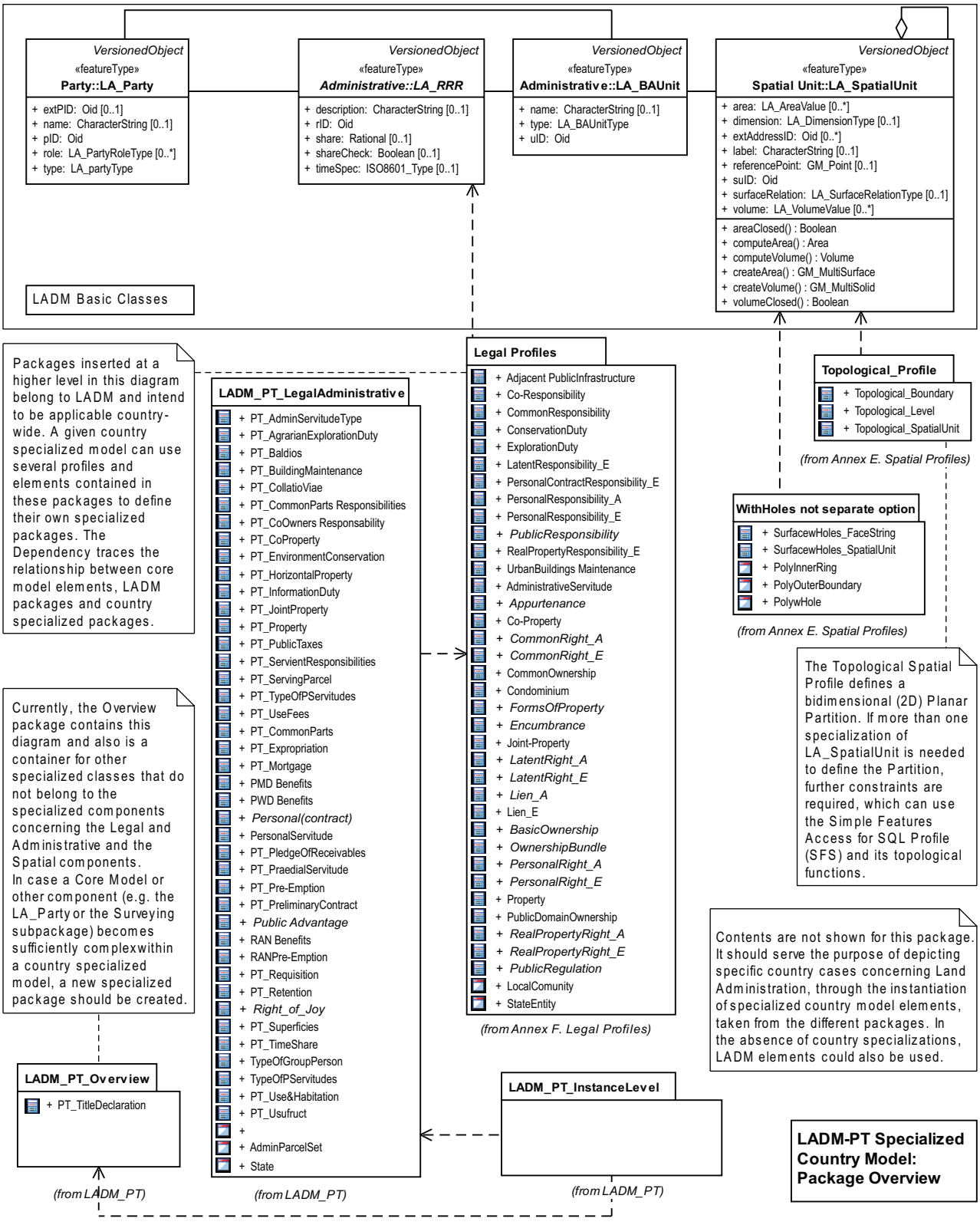


Figure D.1 — Country profile Portugal – Package overview

NOTE 1 The Portuguese country profile is the result of academic research towards a methodology to derive a specialized model from the LADM domain model, using state-of-the-art information technologies. Currently, a new Cadastral Data Model complying with a number of ISO international 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 (Figure D.2).The package overview lists all the classes created for the country profile, grouped into two packages: LegalAdministrative and SpatialUnit. Other packages based on the 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.6) and 2D Polygon (Figure E.5). 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 the LADM packages and the use of the 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 can be defined in order to implement such classes in a spatial database.

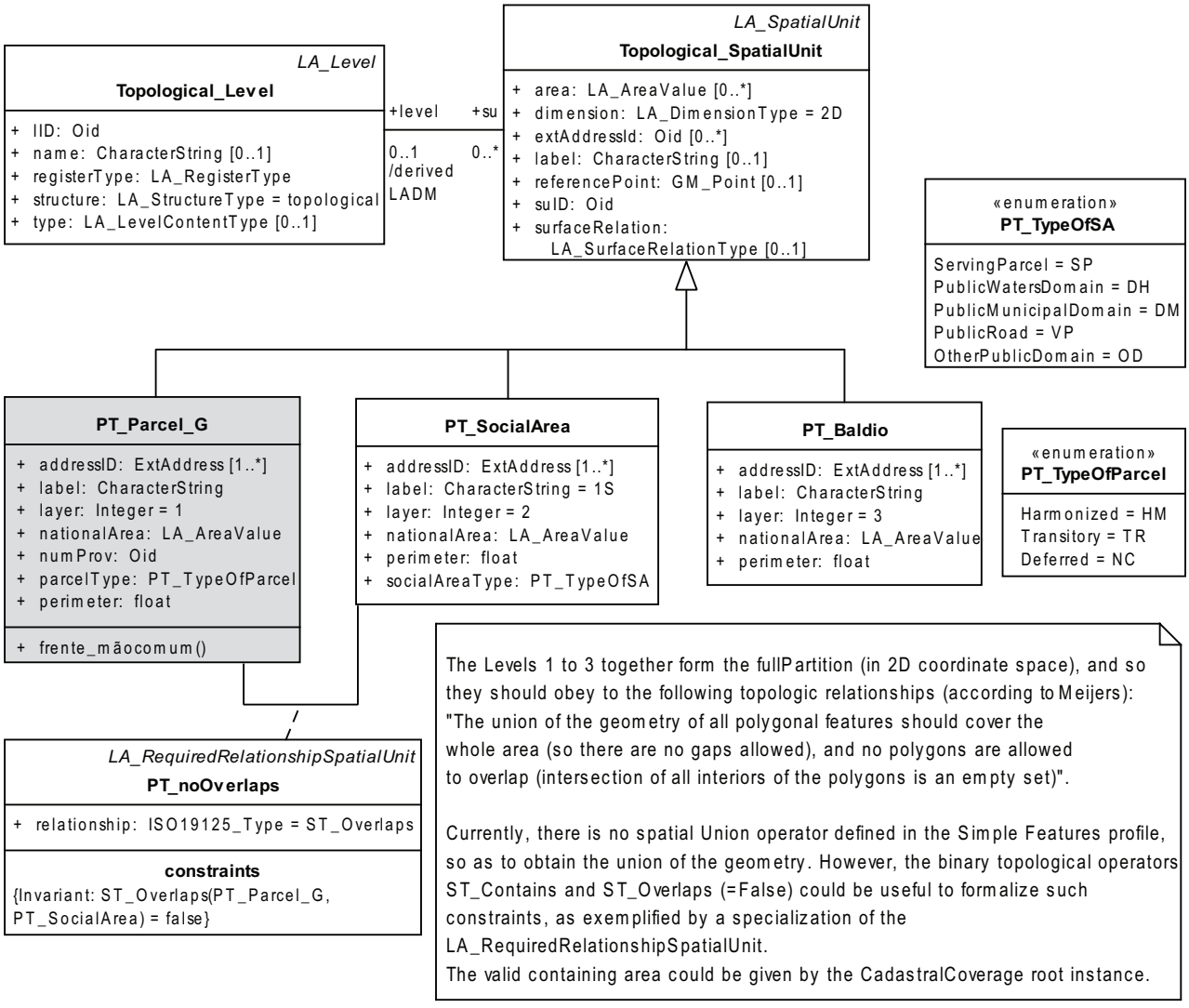


Figure D.2 — Country profile Portugal – Specializations of Spatial Unit

The concept behind this diagram is that any location within the country territory can 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 can 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.

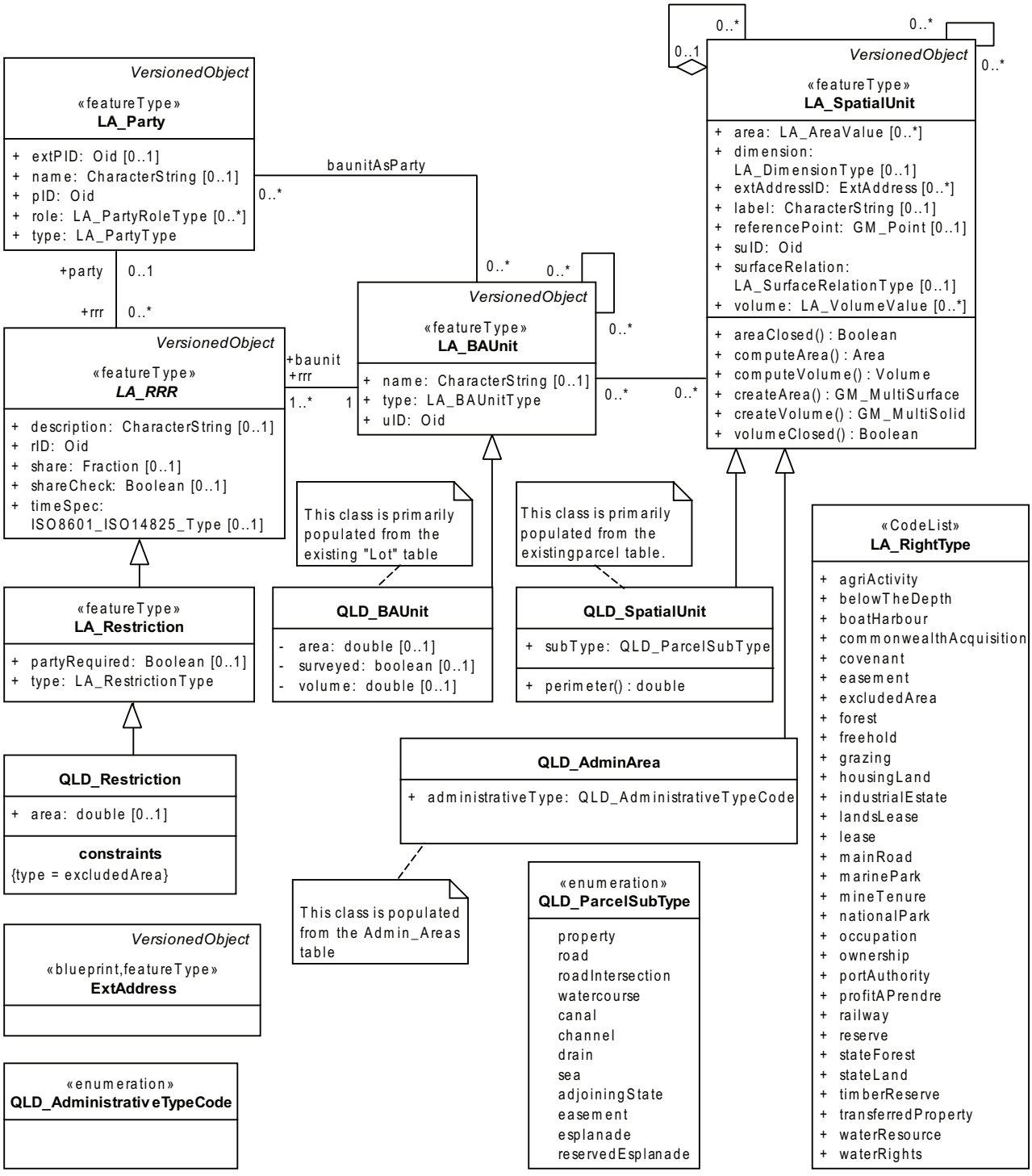


Figure D.3 — Country profile Queensland, Australia

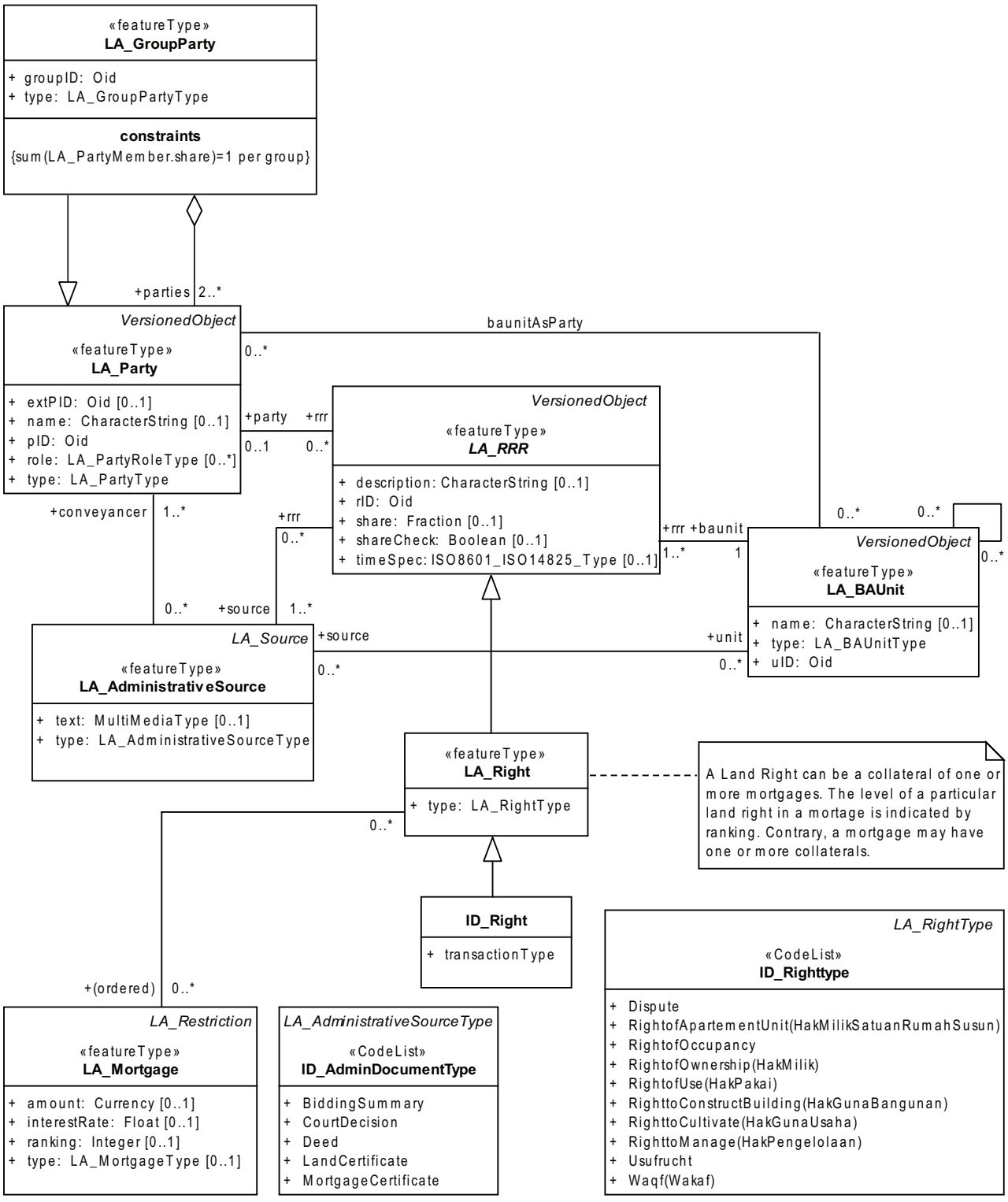


Figure D.4 — Country profile Indonesia

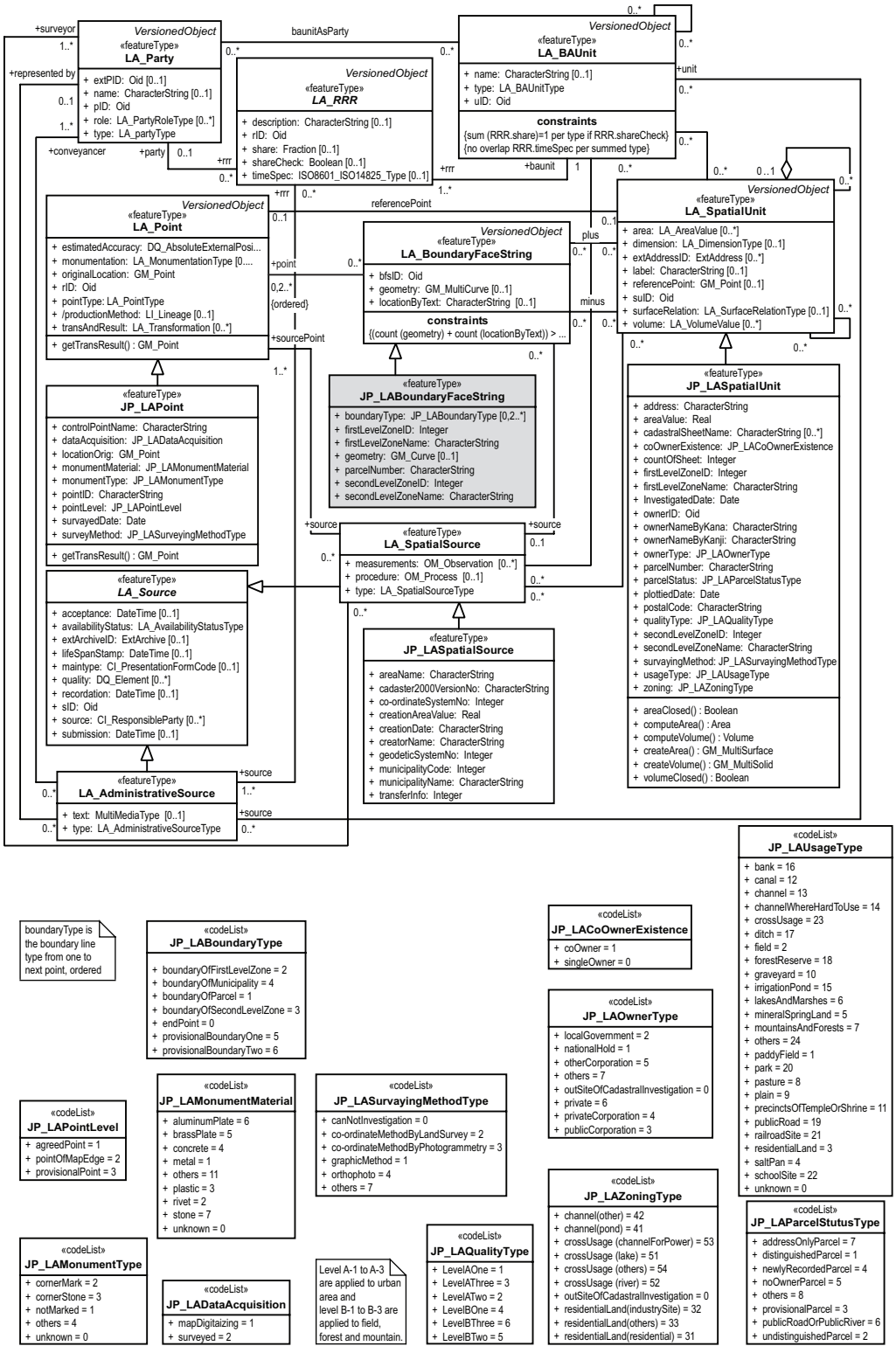


Figure D.5 — Country profile Japan

NOTE 2 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.

NOTE 3 This profile is a sample of possible LADM applications in Japan. Each actual implementation is not limited to the profile.

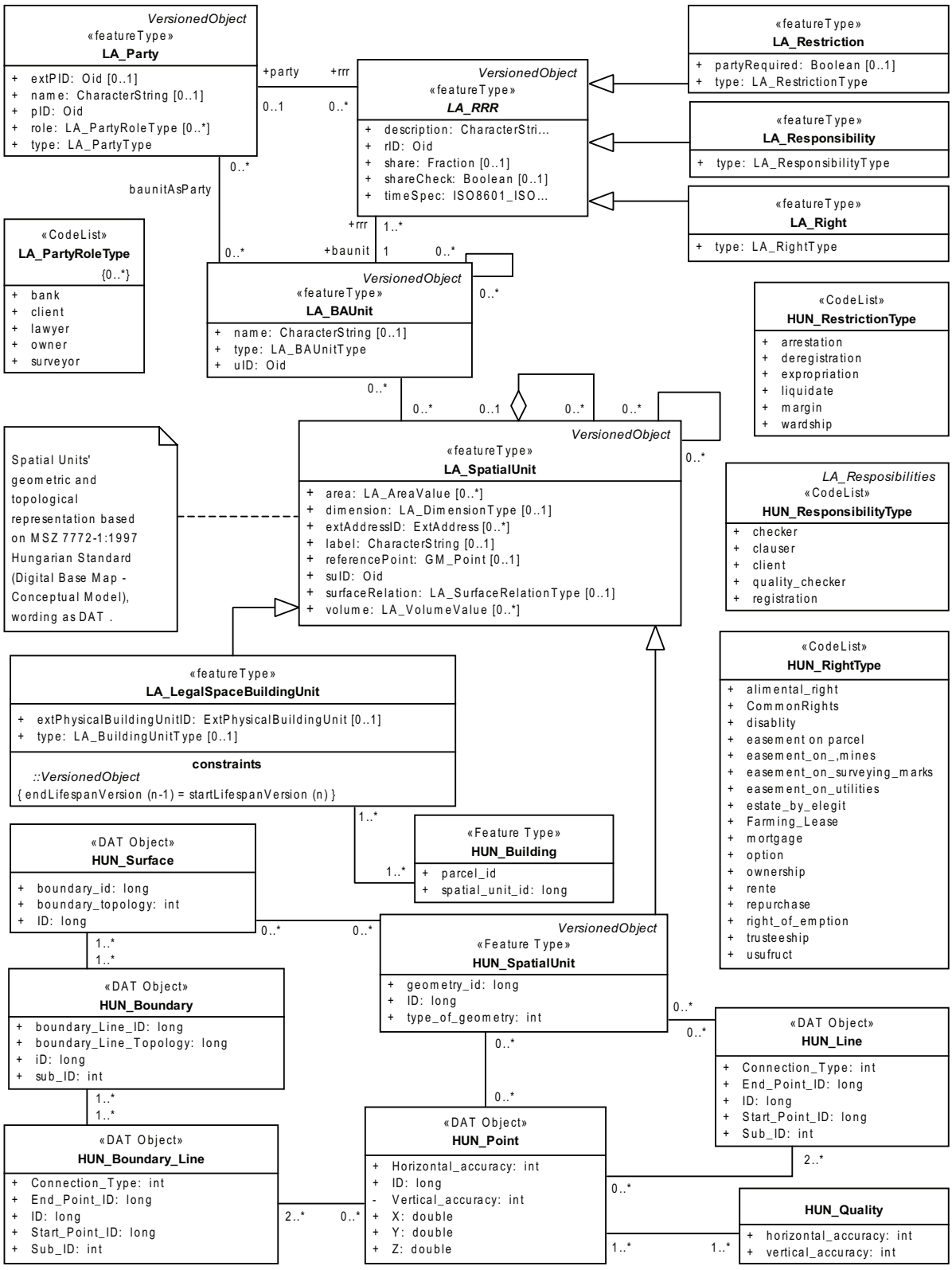


Figure D.6 — Country profile Hungary

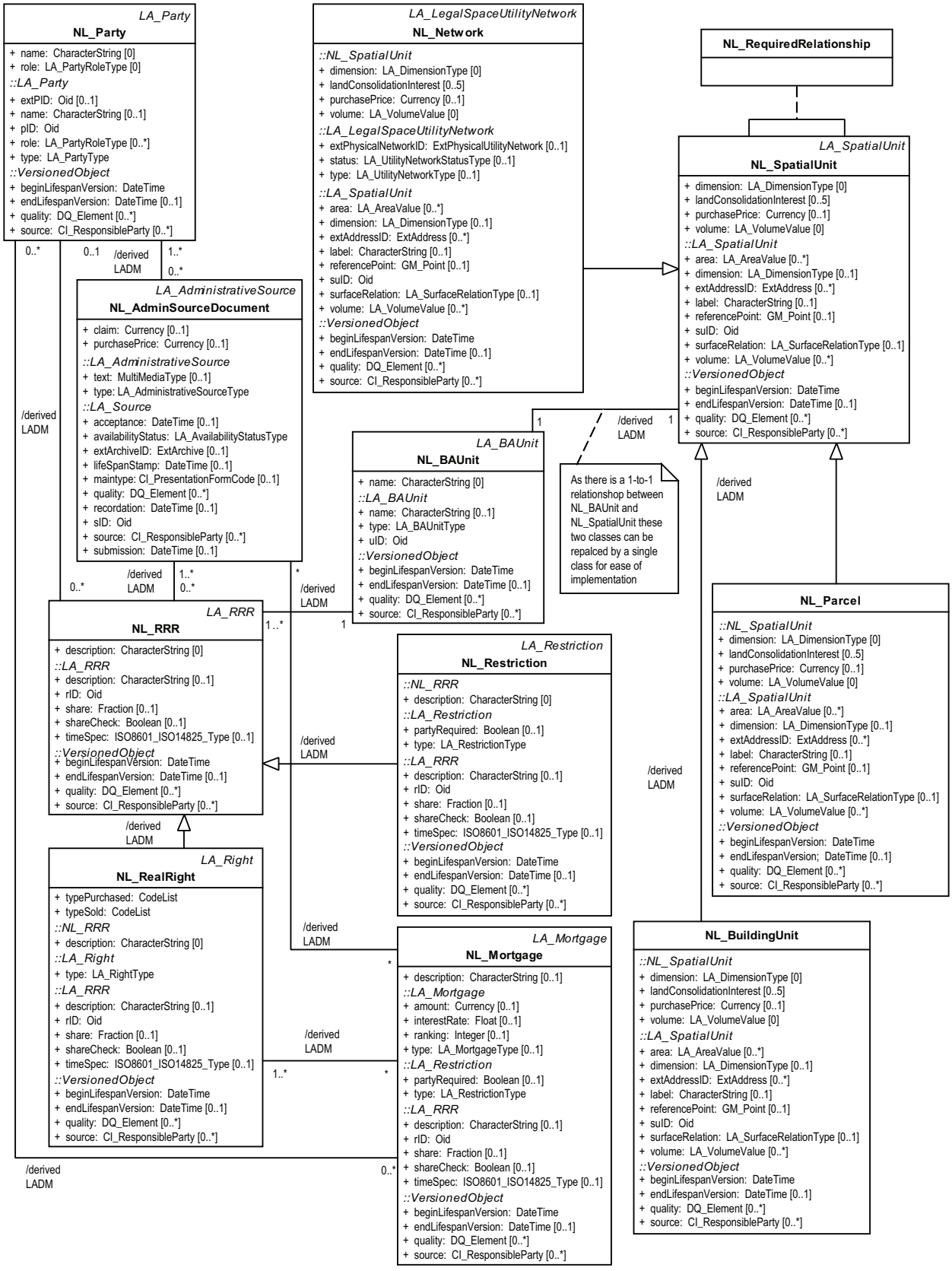


Figure D.7 — Country profile The Netherlands

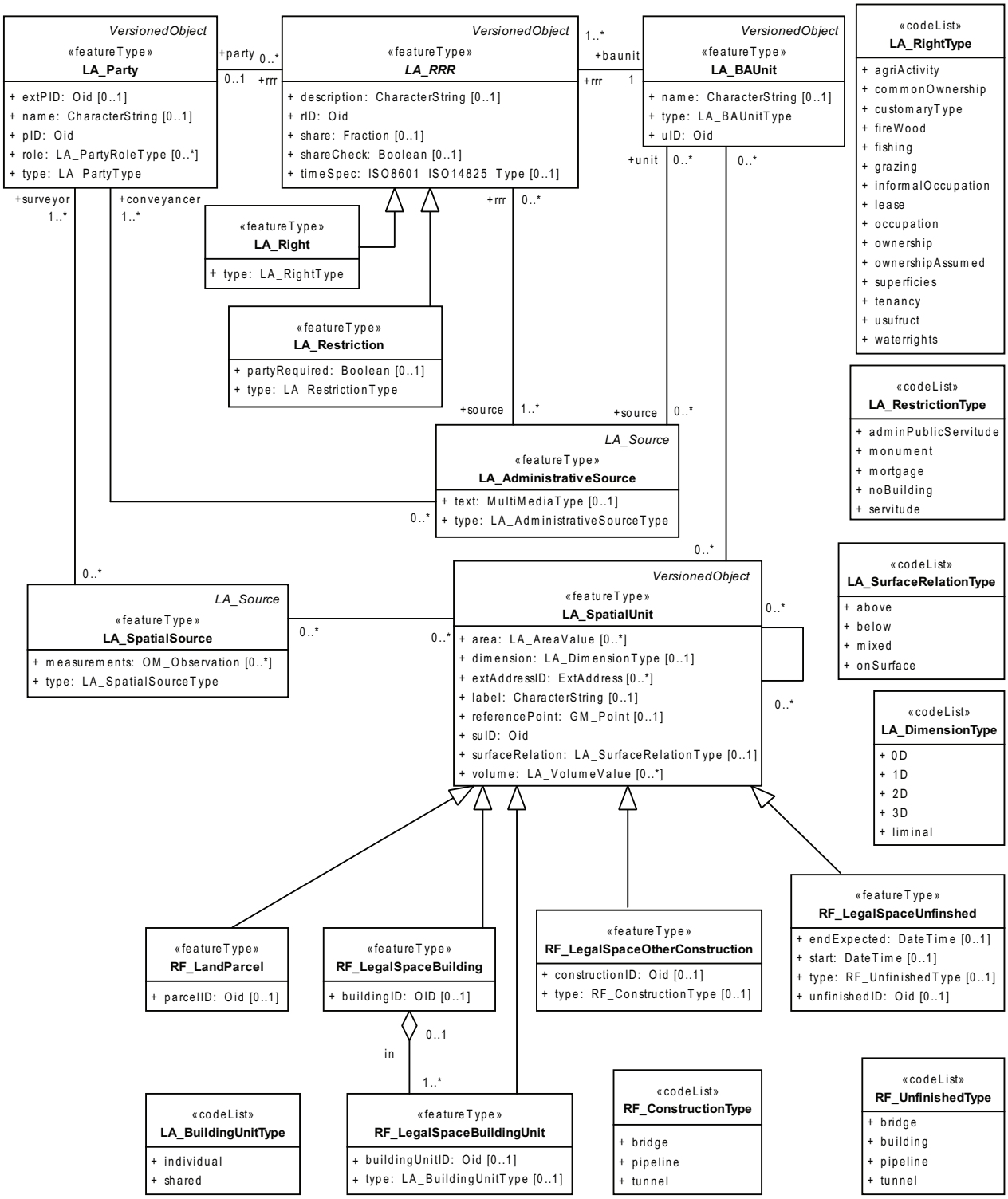


Figure D.8 — Country profile Russian Federation

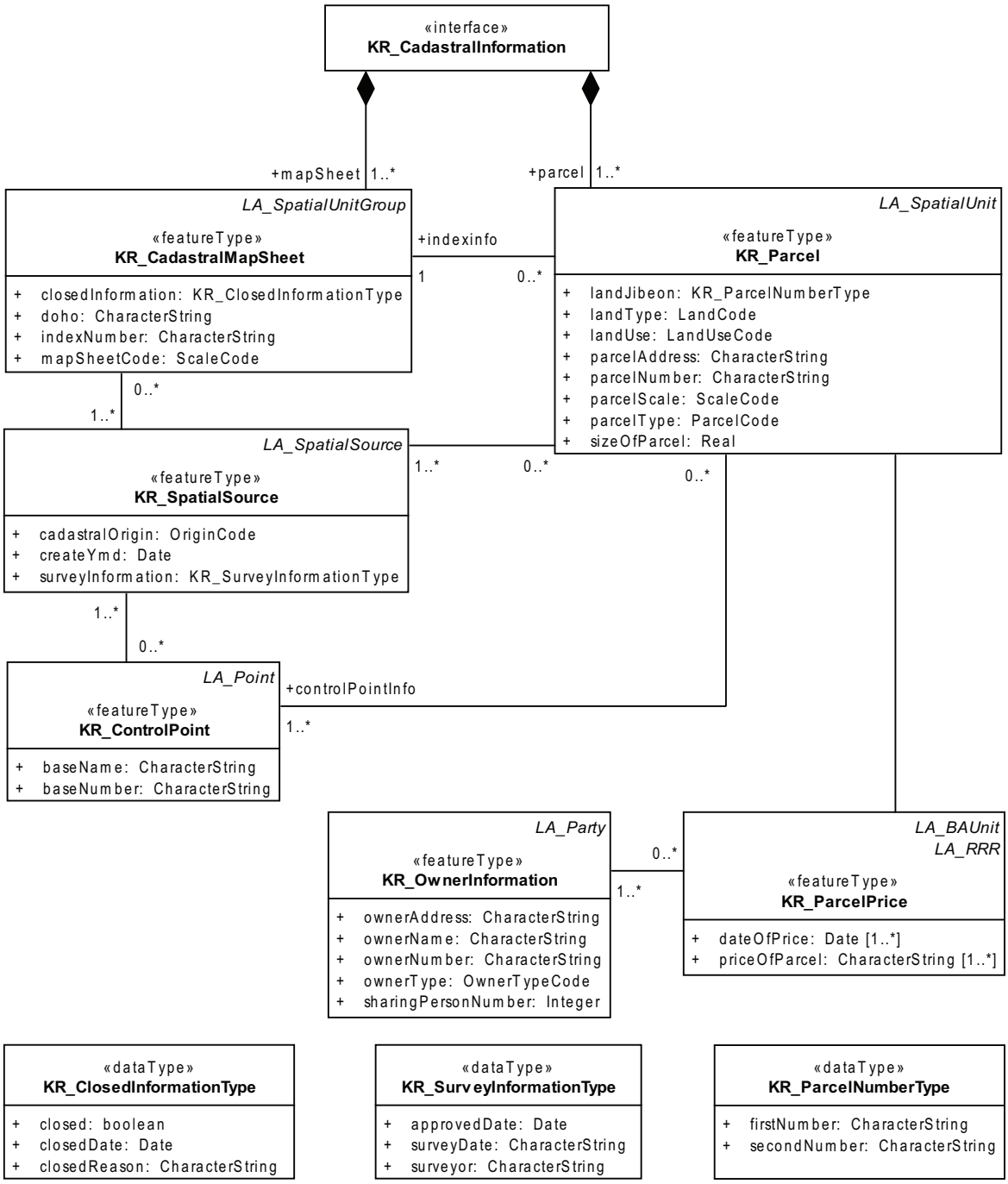


Figure D.9 — Country profile Republic of Korea

Annex E
(informative)

Spatial units and spatial profiles

The 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 can 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 can 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 together form 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. For 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 can occur in both 2D and 3D.

It should 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 can be a base level (Level 1) with ownership spatial units, which are topologically defined, and there can be an additional level (Level 2) with polygon based spatial units representing servitudes. The concept of levels can 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) can cross. The temporal topology shall also be maintained: that is, no time gaps or overlaps should 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 the 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. The 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).

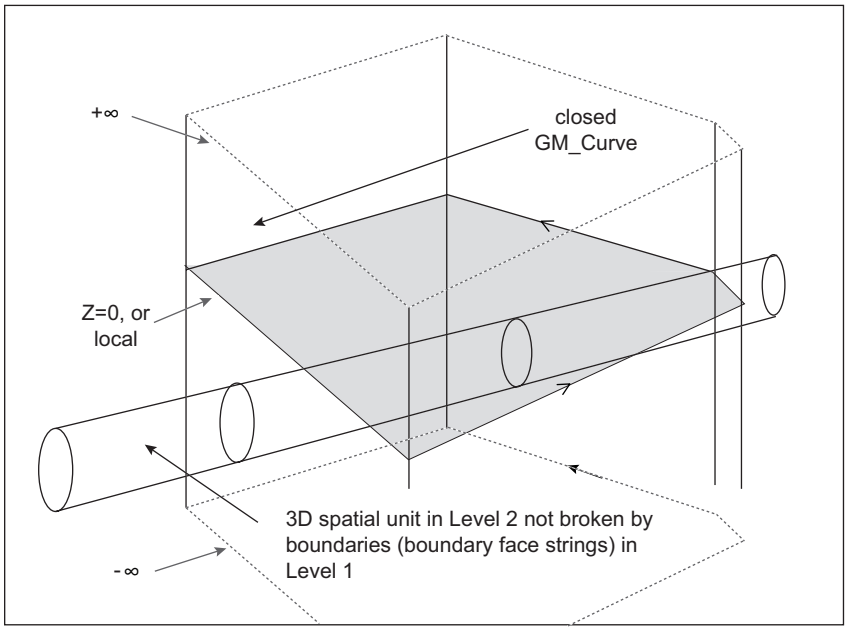


Figure E.1 — The notion of multiple levels

The Surveying and Representation subpackage of the 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 the required classes and attributes per spatial profile. 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)

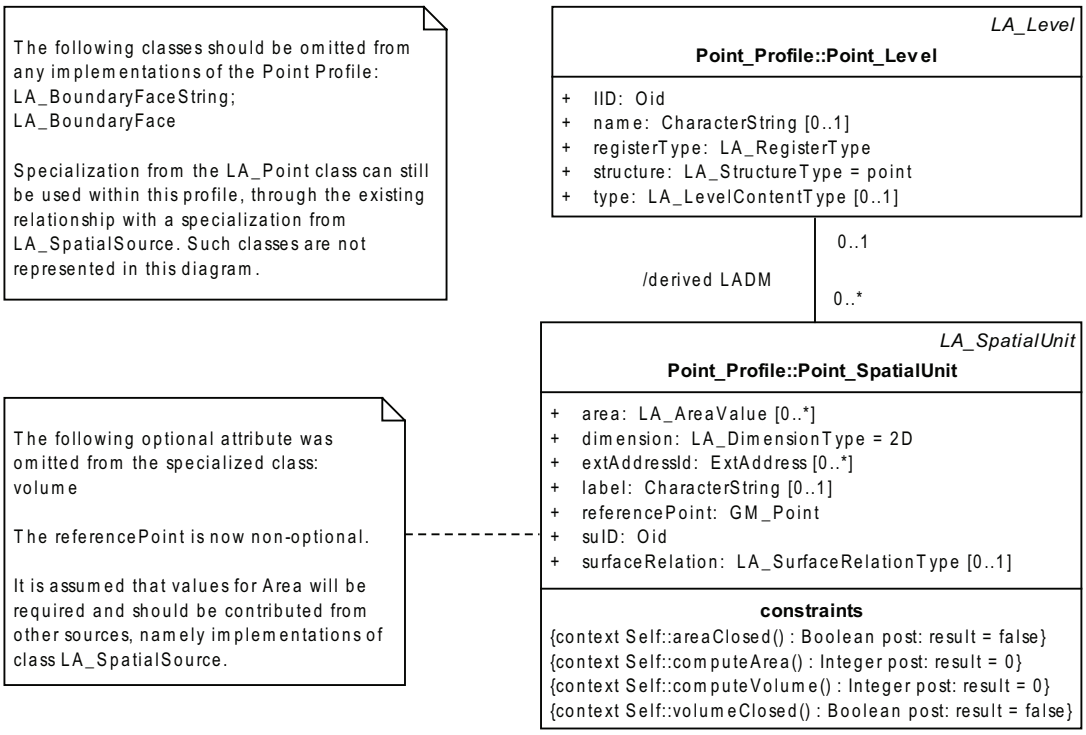


Figure E.2 — 2D Point based

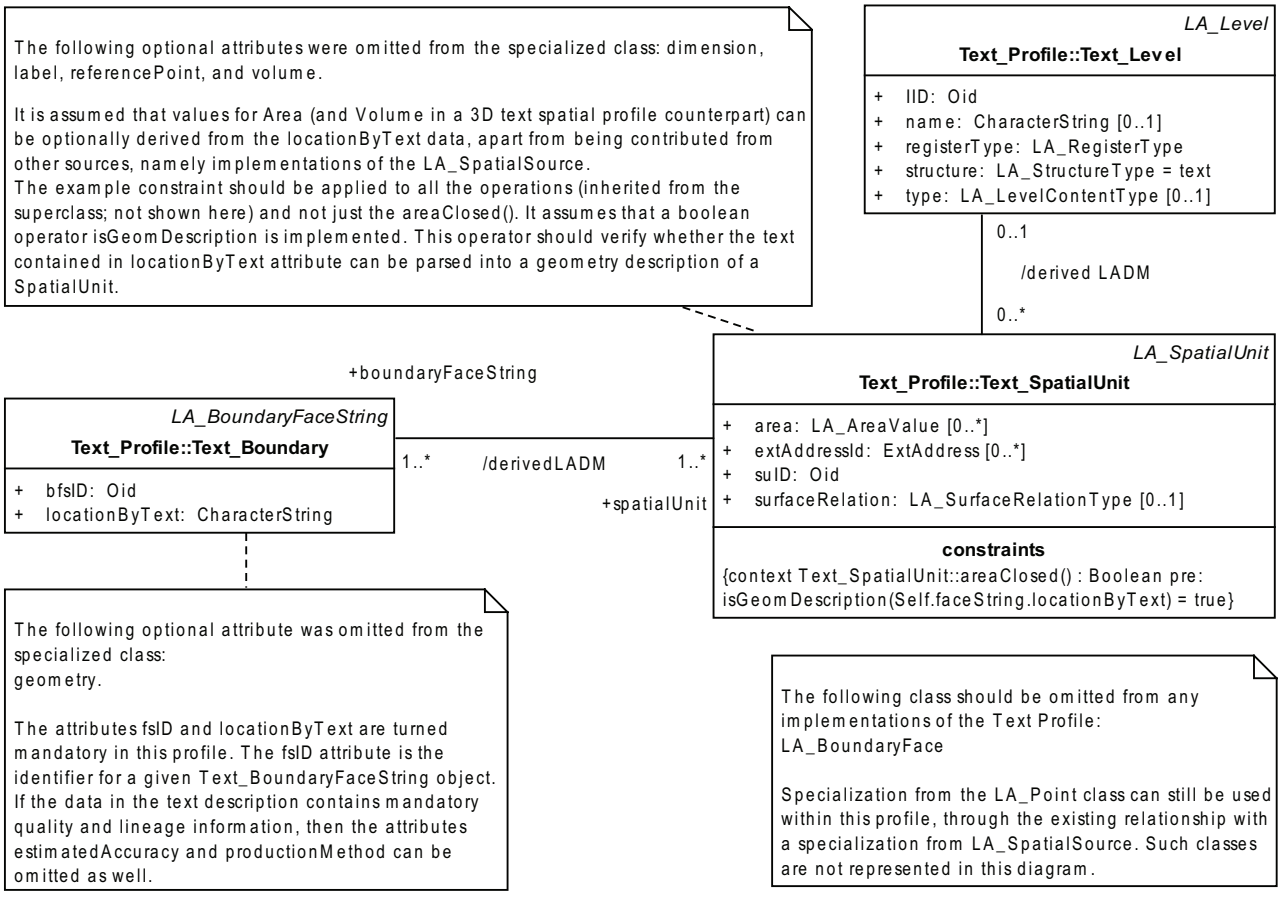


Figure E.3 — 2D Text based

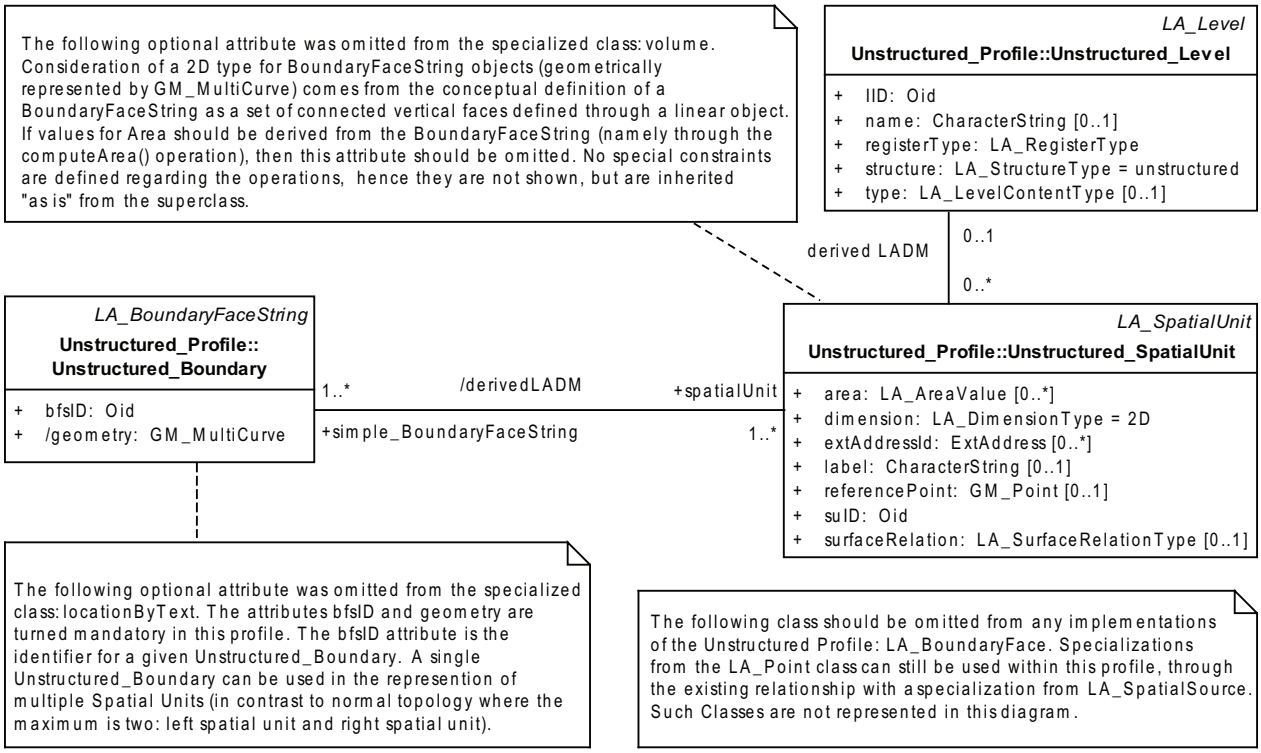


Figure E.4 — 2D Unstructured (line) based

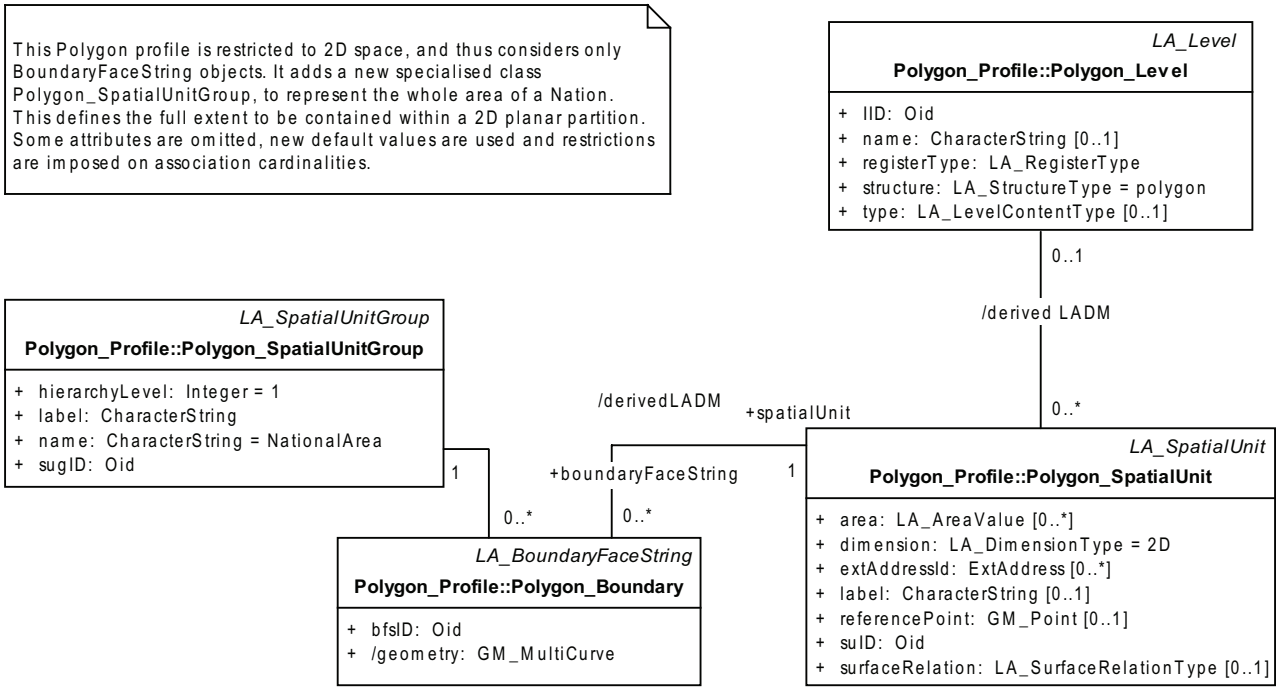


Figure E.5 — 2D Polygon based

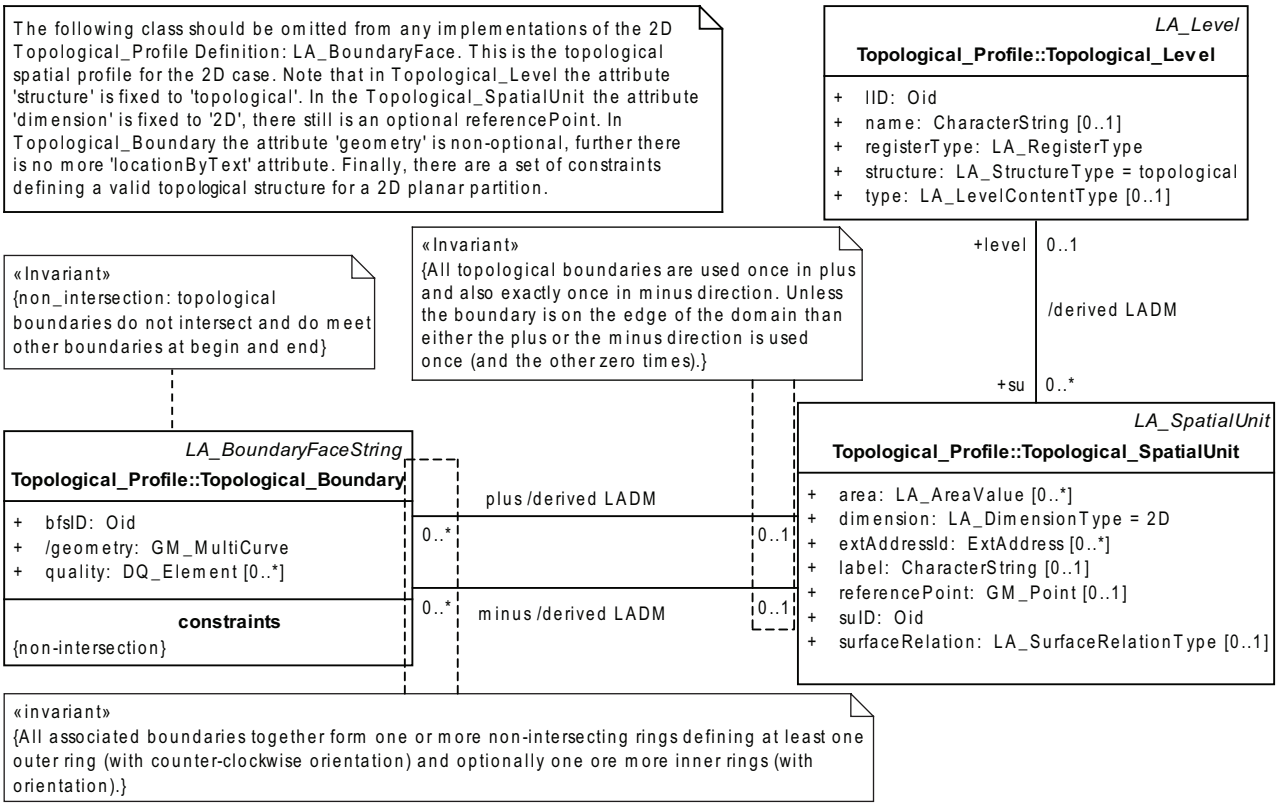


Figure E.6 — 2D Topological based

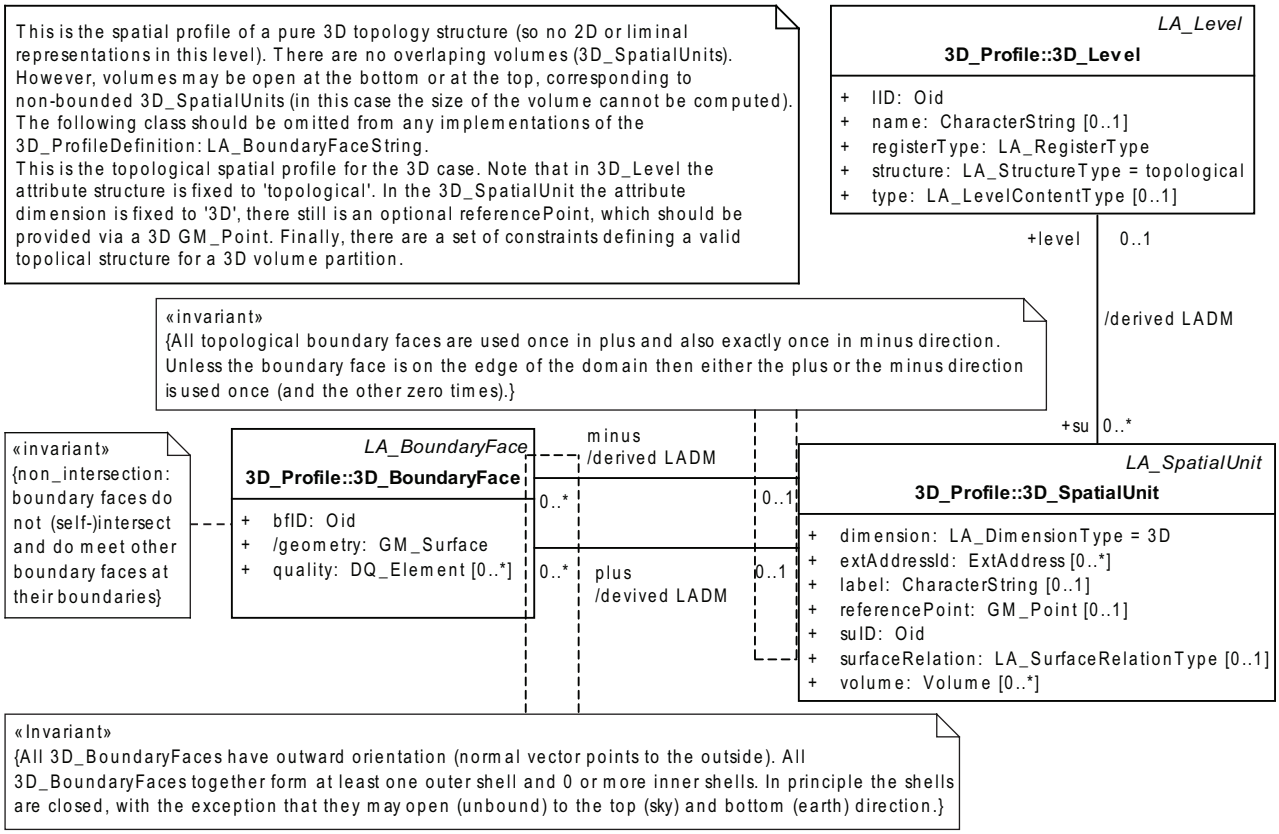


Figure E.7 — 3D Topological based

Annex F
(informative)

Legal profiles

A legal profile is a profile 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).

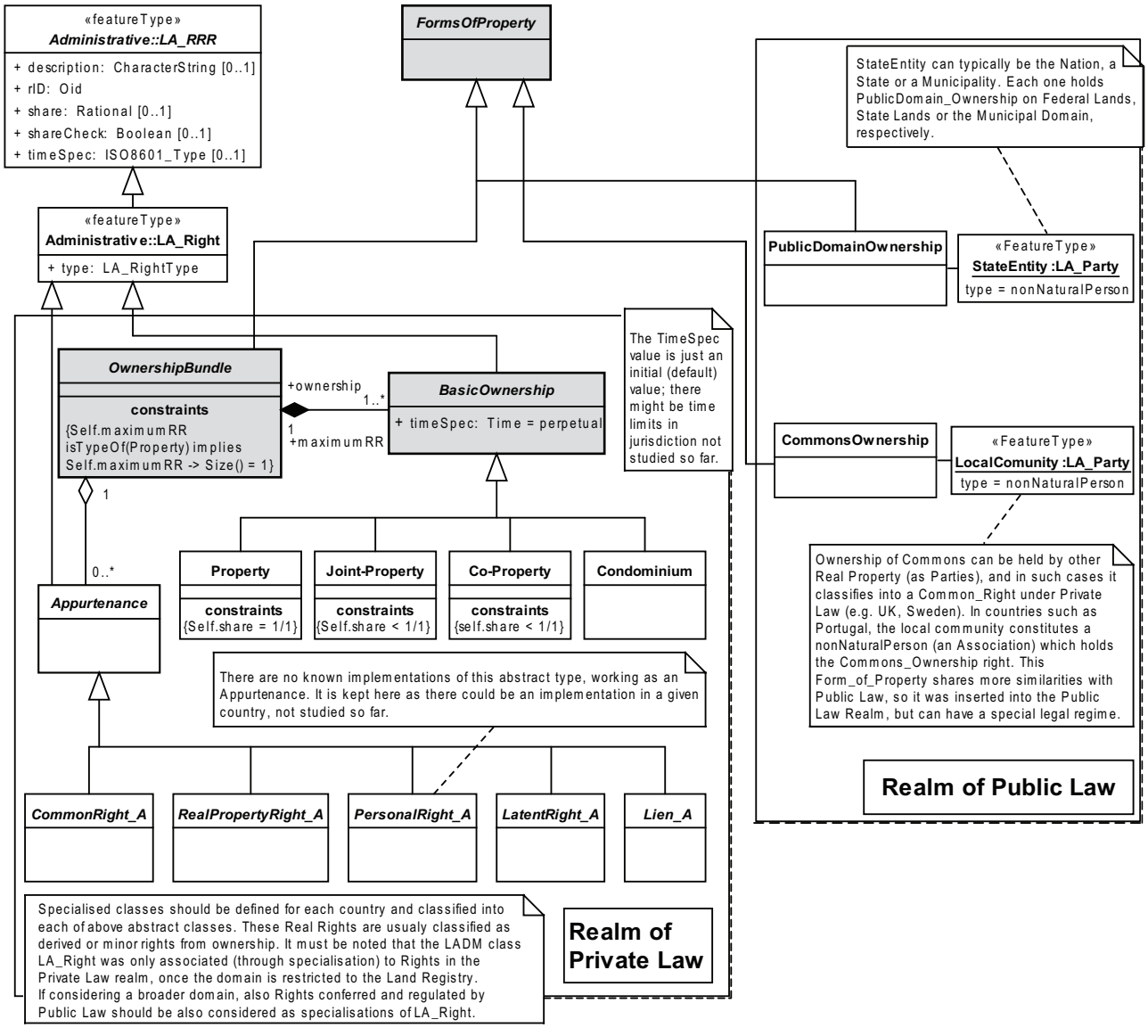


Figure F.1 — Legal profile for rights

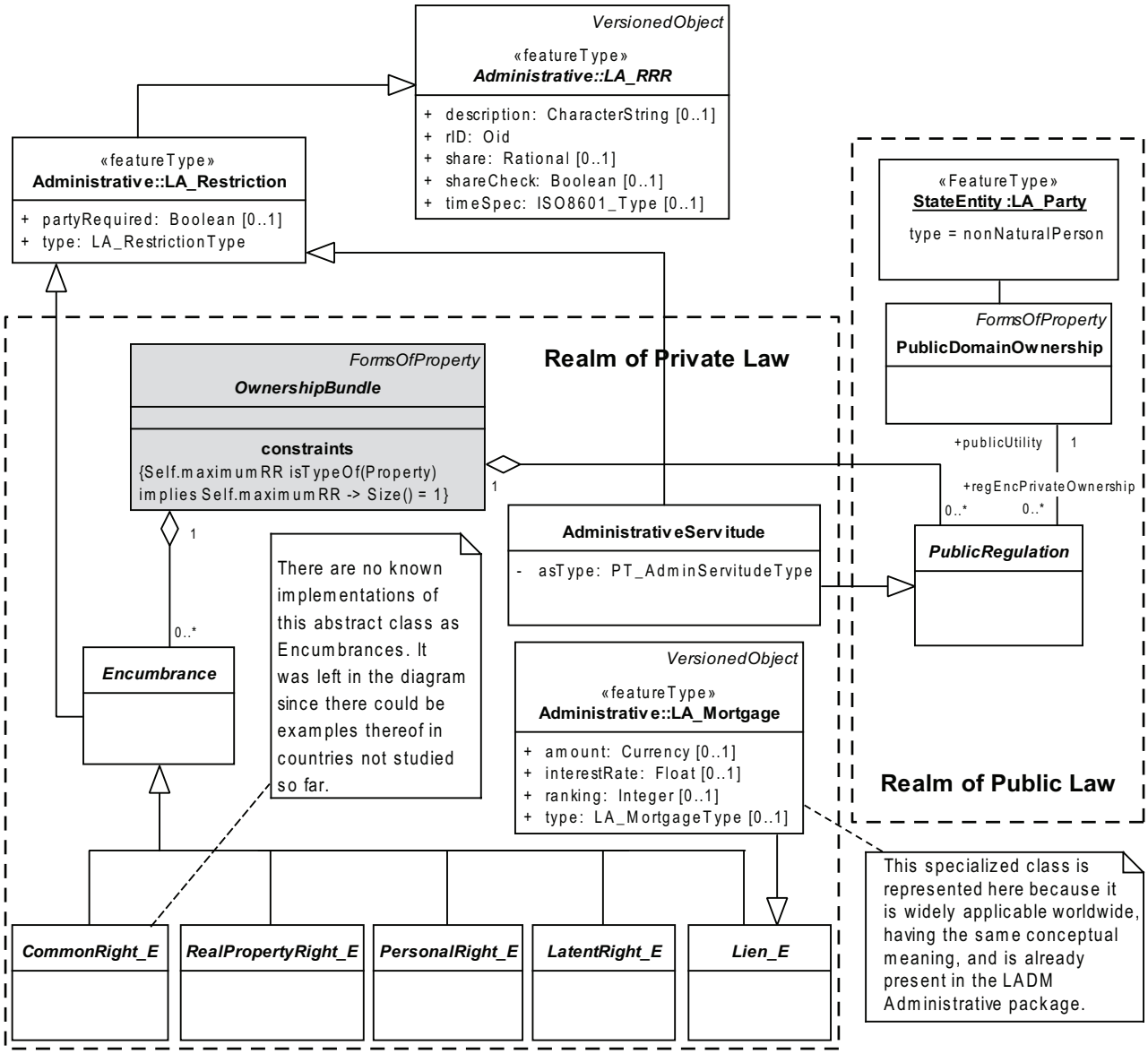


Figure F.2 — Legal profile for restrictions

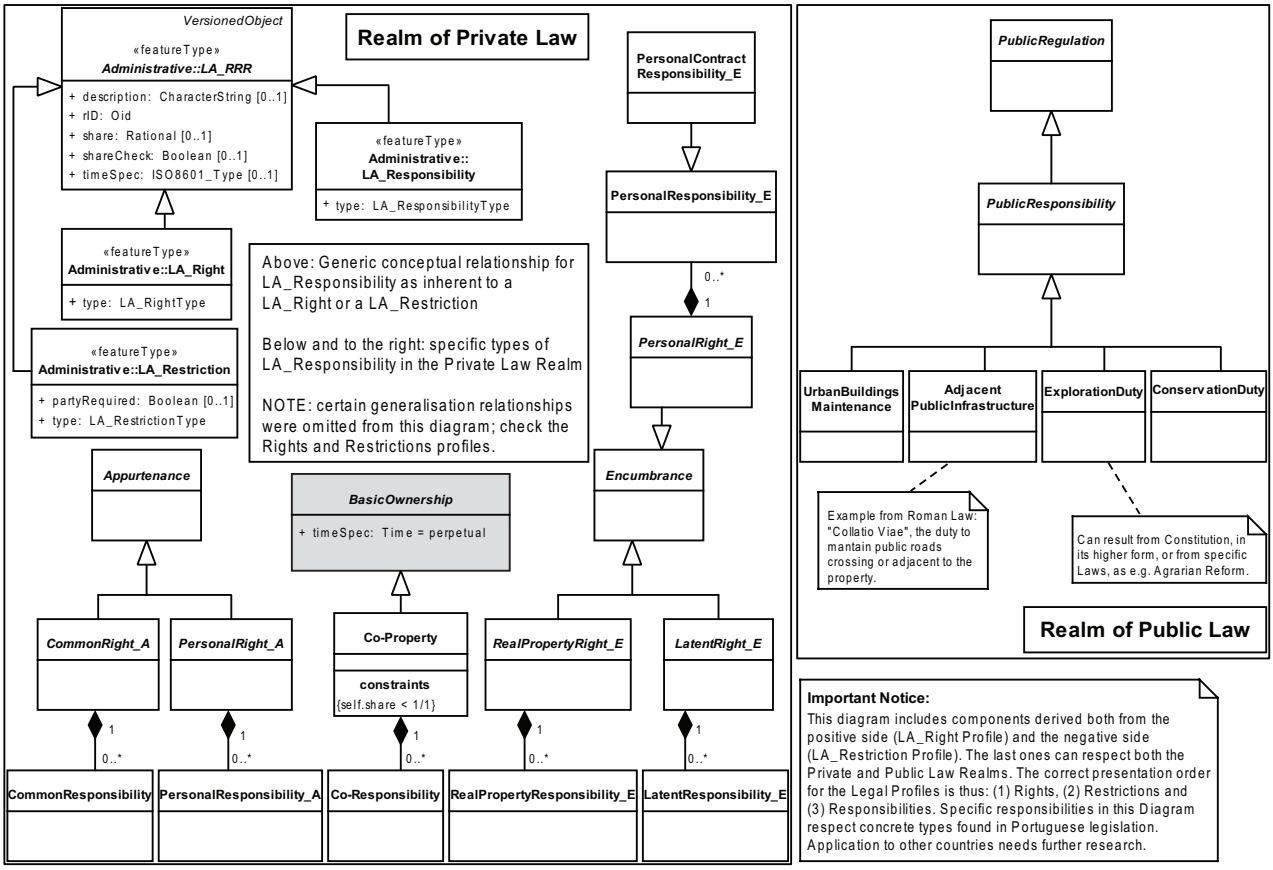


Figure F.3 — Legal profile for responsibilities

Annex G
(informative)

The LADM and INSPIRE

For cross-border access of geo-data, a European metadata profile based on ISO international standards is under development using rules of the implementation defined by the Infrastructure for Spatial Information in the European Community – INSPIRE [5]. 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 [6]. Cadastral parcels in INSPIRE can serve the purpose of generic information locators for environmental applications, i.e. searching and linking other spatial information.

The INSPIRE Directive requires that existing standards are taken into account (article 7 of the Directive). ISO 19152 can be taken into account when there is a requirement and consensus to extend the Data Specification for cadastral parcels. An excellent opportunity to align the LADM with INSPIRE cadastral parcels (CP) presented itself as both were 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 the LADM, and resulted in a matching of concepts and compatible definitions of common concepts. Of course it should be remembered that there are differences in scope and targeted application areas, e.g. INSPIRE has strong focus on environmental users, while the LADM has a multi-purpose character (supporting legal security, taxation, valuation, planning, etc.) and the LADM is supporting both data producers and data users in these various application areas. Also, the 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 this intensive cooperation, it is now possible for a European country to be compliant with both INSPIRE and with the LADM. In addition, it is now possible to extend the INSPIRE specifications using the LADM, if there is a requirement 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 the LADM, using inheritance, adding attributes and constraints it has been possible to express the INSPIRE cadastral parcels data set in the 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 the 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 than 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).

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

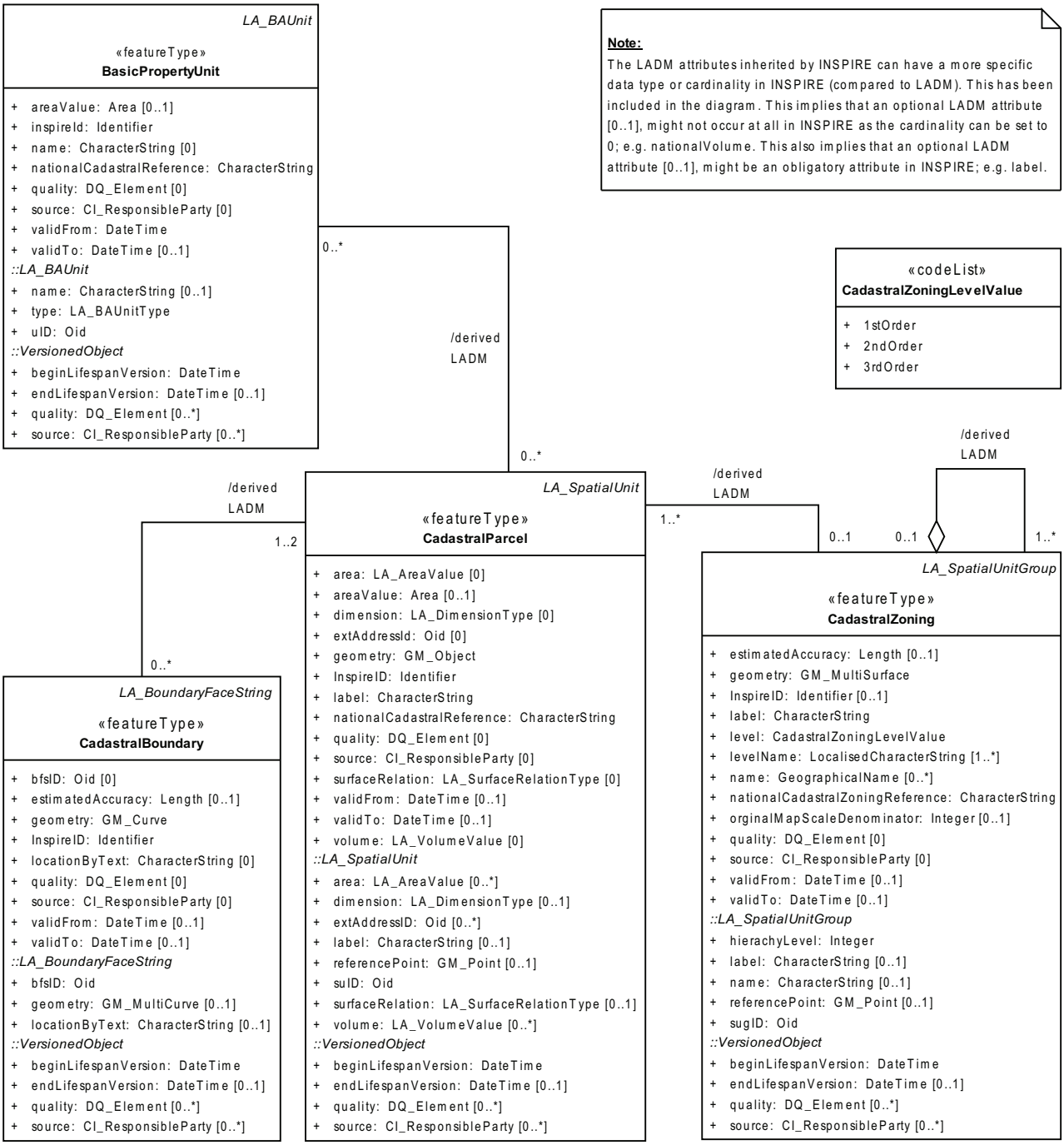


Figure G.1 — The INSPIRE cadastral parcel model based on the LADM

Annex H
(informative)

The LADM and LPIS

H.1 The integration of the 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 already developed 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 were 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 the 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 [23]. In the following example, a data model is designed that implies the collaboration or integration of the LADM and LPIS. The standardization initiative in the area of LPIS [20], [3] by the Joint Research Centre (JRC) of the European Commission is used in this example, in order to represent potentials for integration/collaboration between the LADM and LPIS.

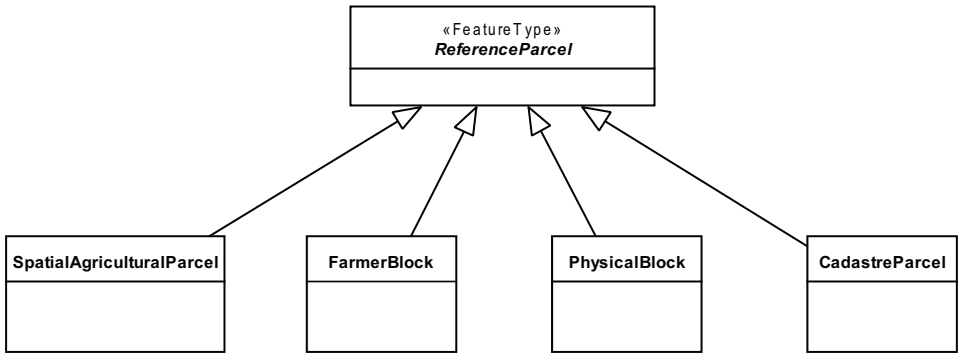


Figure H.1 — Reference parcel types

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 H.2, the concept of SubParcel is introduced, which plays the role of a reference parcel (and as glue between the LADM and LPIS).

H.2 A data model for the integration of the 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 Centre (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.

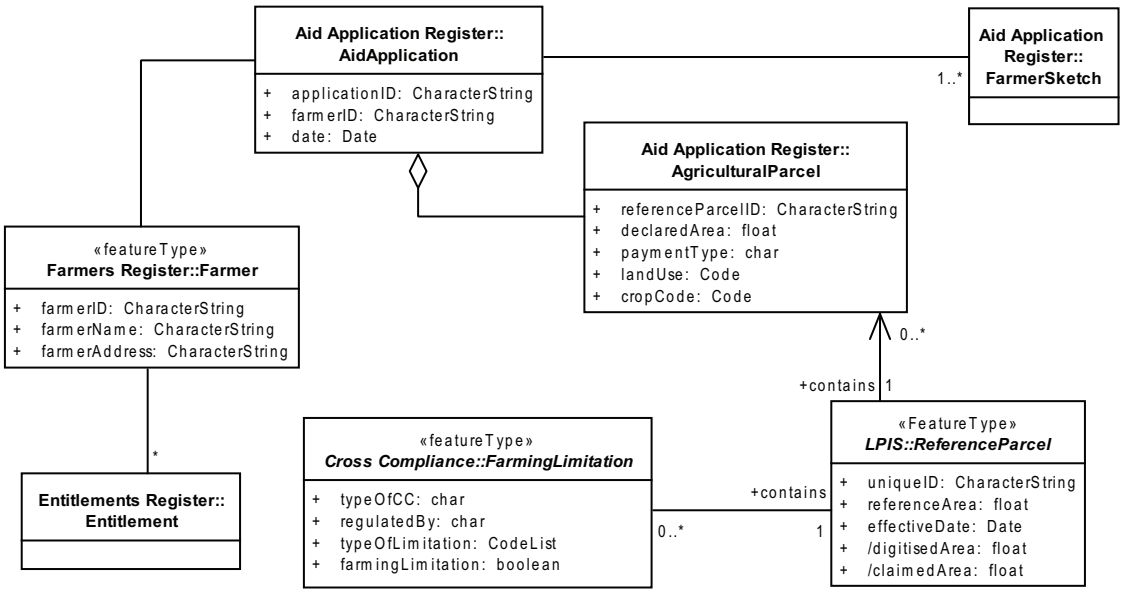


Figure H.2 — The core (classes) of the LCM

H.2.3 Integration of LCM and the LADM basic classes

H.2.3.1 Spatial classes

The class LA_SpatialUnit is one of the basic classes of the LADM. The 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 are stable over time. Otherwise, the update and maintenance procedures will definitely be a burden.

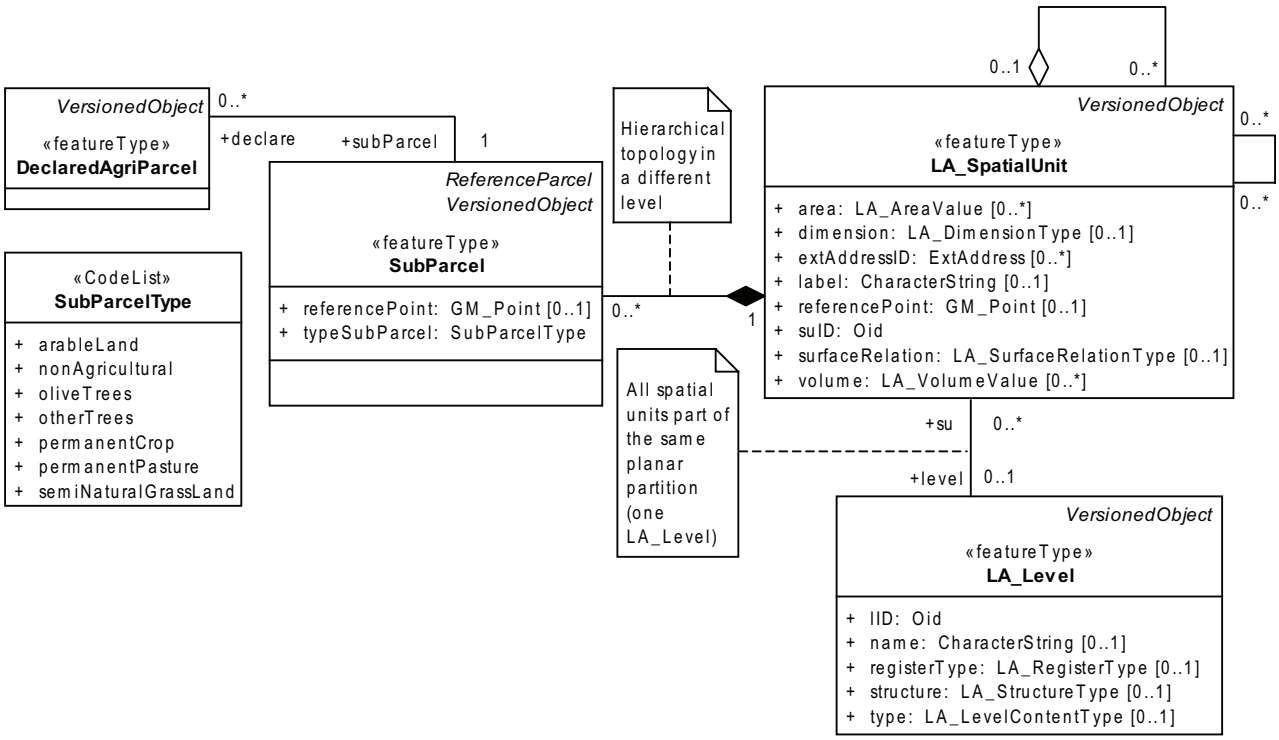


Figure H.3 — Spatial classes for the LADM – IACS/LPIS collaboration

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 the LADM. Other classes are designed for the description of LPIS administrative data.

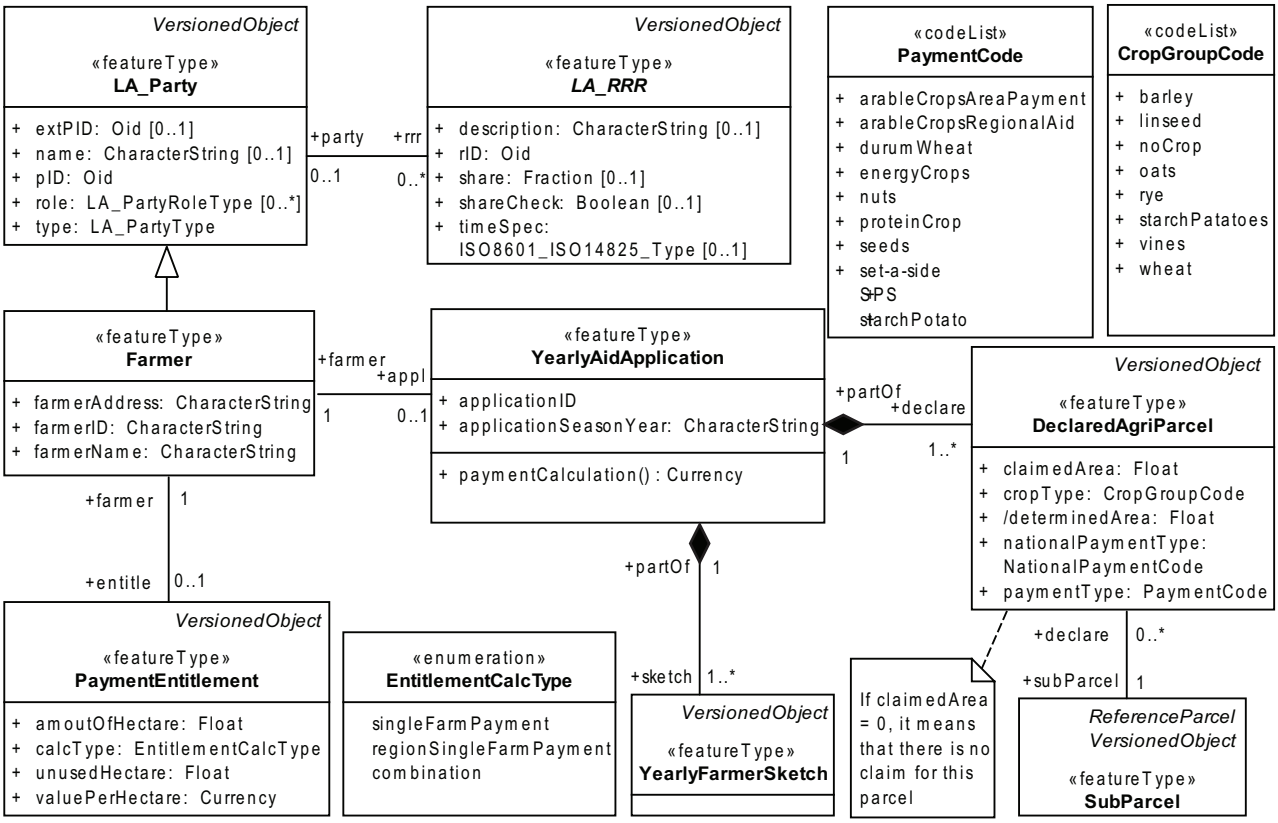


Figure H.4 — Administrative classes for the LADM – LPIS integration

Farmer class is designed as a specialization of LA_Party class in order to handle the attributes specific to farmers. Farmers can apply for agricultural subsidies every year. To handle the application information of farmers, YearlyAidApplication class is designed. Aid applications submitted by farmers should be accompanied by farmer declarations which describe each piece of land used by a 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 should provide together with their applications, they indicate the boundaries of their agricultural parcels. They can use one single agricultural parcel or many of them. They can 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 should 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 the LADM and LPIS

A farmer is defined in article two of the EC Regulation 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 the 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, the 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.

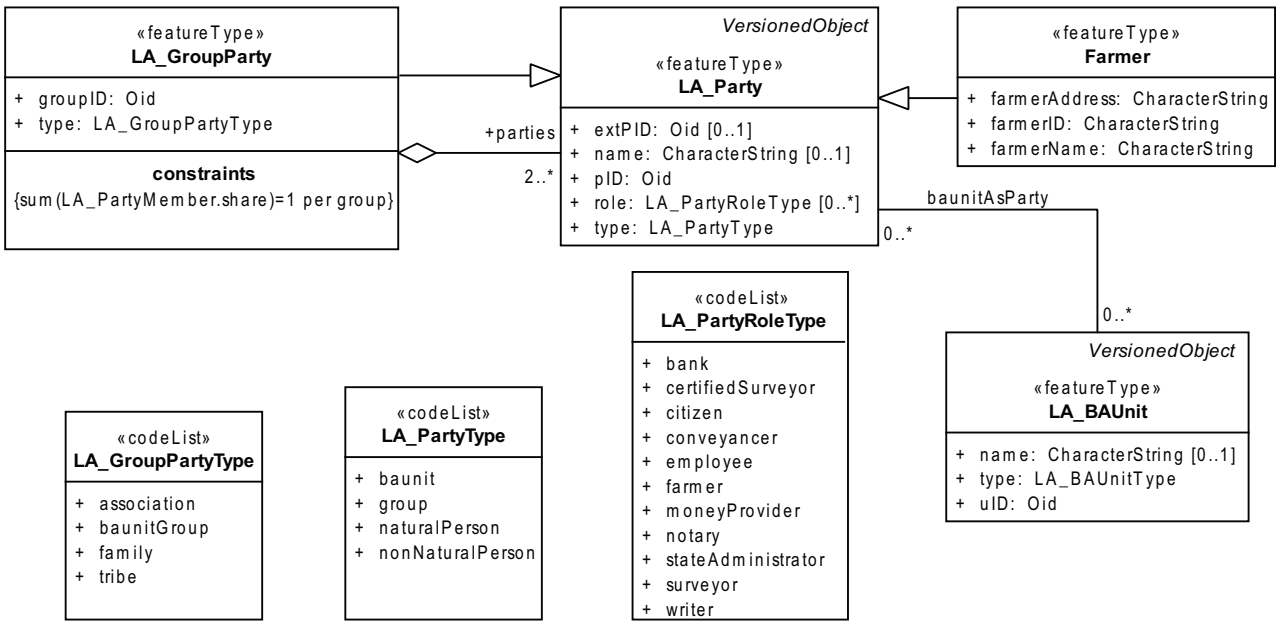


Figure H.5 — Person classes: LA_Party, LA_GroupParty and Farmer

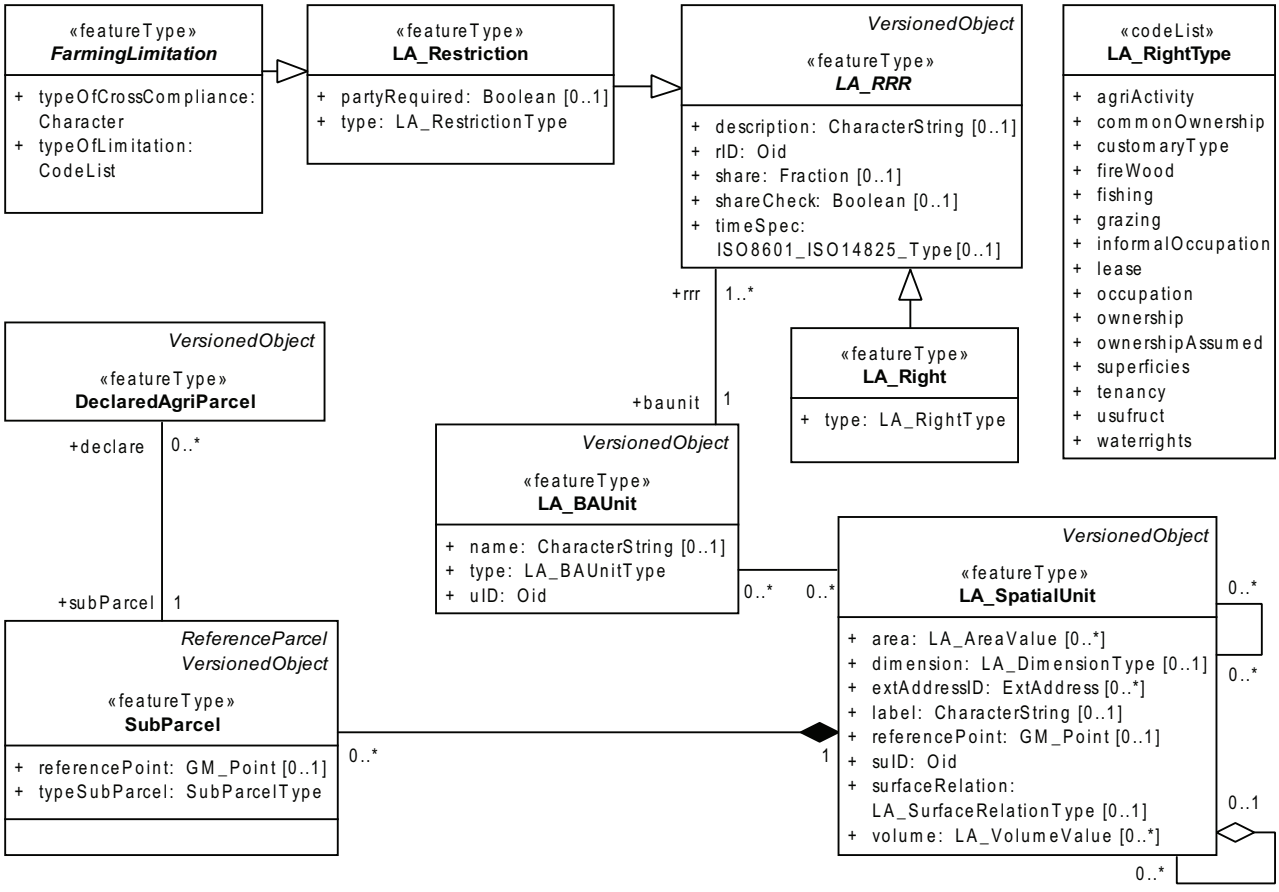


Figure H.6 — Associations of rights and restrictions to DeclaredAgriParcel class

In the 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 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 the 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 [4].

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 cannot 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 can own some land for their activities. They can lease and/or get some kind of consent from others for another piece of land.

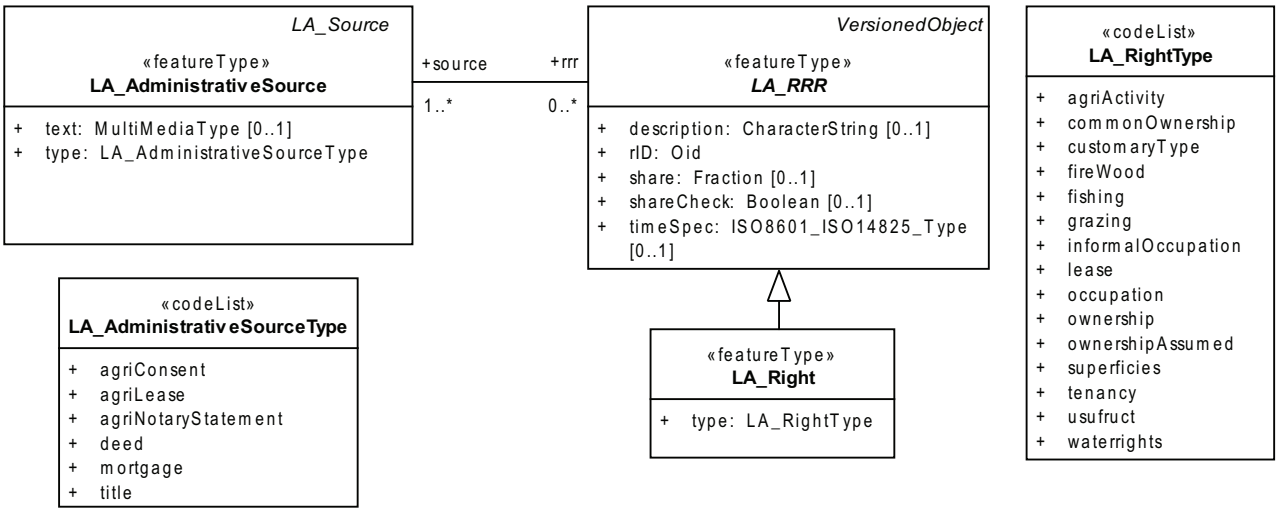


Figure H.7 — Registration of farming rights with the LADM classes

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) are to be elaborated, including activity diagrams of the processes and workflows.

Annex I
(informative)

Social Tenure Domain Model (STDM)

The STDM is an initiative of UN-HABITAT to support pro-poor land administration [26]. 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 will support all forms of land rights, social tenure relations, and overlapping claims to land [29], [2]. It should be emphasized that the STDM is also a conceptual model and not an application model. Further, both STDM and LADM are descriptive and not prescriptive. They provide formal languages for describing the many aspects of social tenure, so that the similarities and differences between the different LA systems can be better understood. The purpose is that the LADM will contribute to a better understanding of the many aspects of social tenure.

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

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

The LADM originated from areas with formal cadastre and land registry systems. It is observed that STDM contains most of the functionality of the LADM, sometimes under different terminology. Formal terminology as used in the LADM cannot always be applicable because of the informal environment. In STDM most of the same classes as in the 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.

EXAMPLE 2 Parcels (alias for spatial units, see Figure 5), are demonstrated in instance diagrams, see Figure C.2.

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

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 the LADM aim to allow the use of local, regional or national terminology. User communities have to define and manage their own values when implementing this International Standard. Figures J.1 to J.4 show possible examples of values for these code lists.

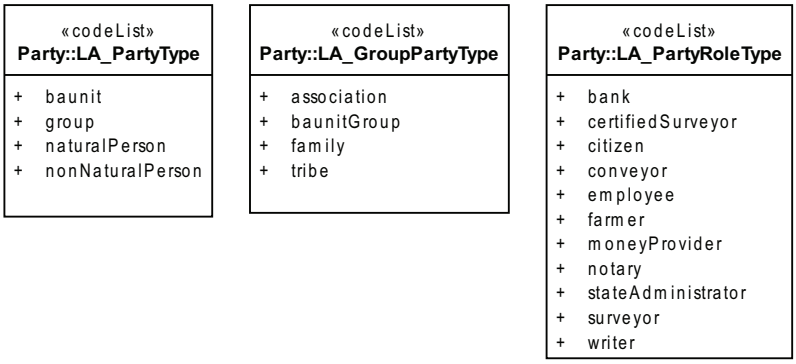


Figure J.1 — Code lists for Party Package

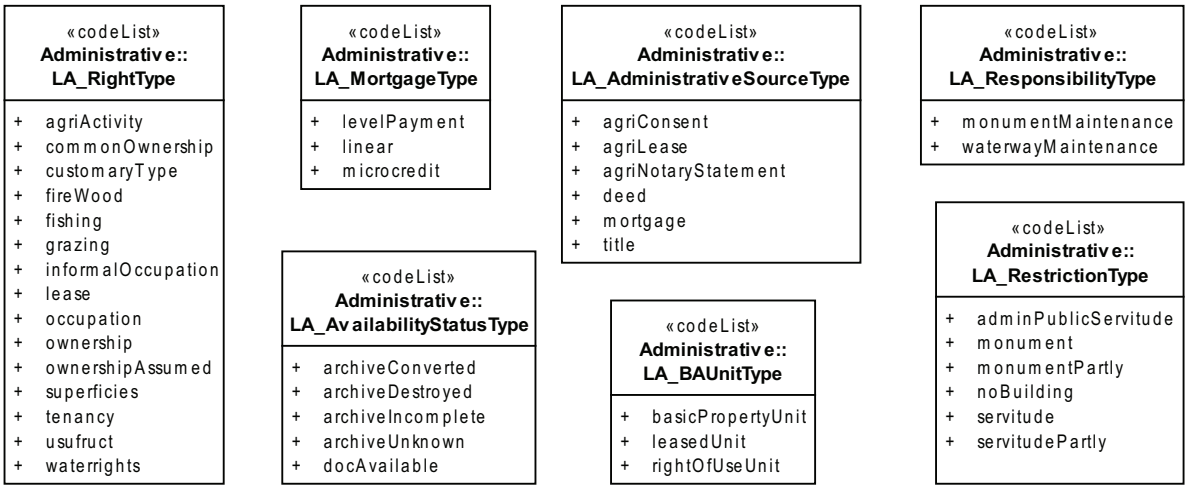


Figure J.2 — Code lists for Administrative Package

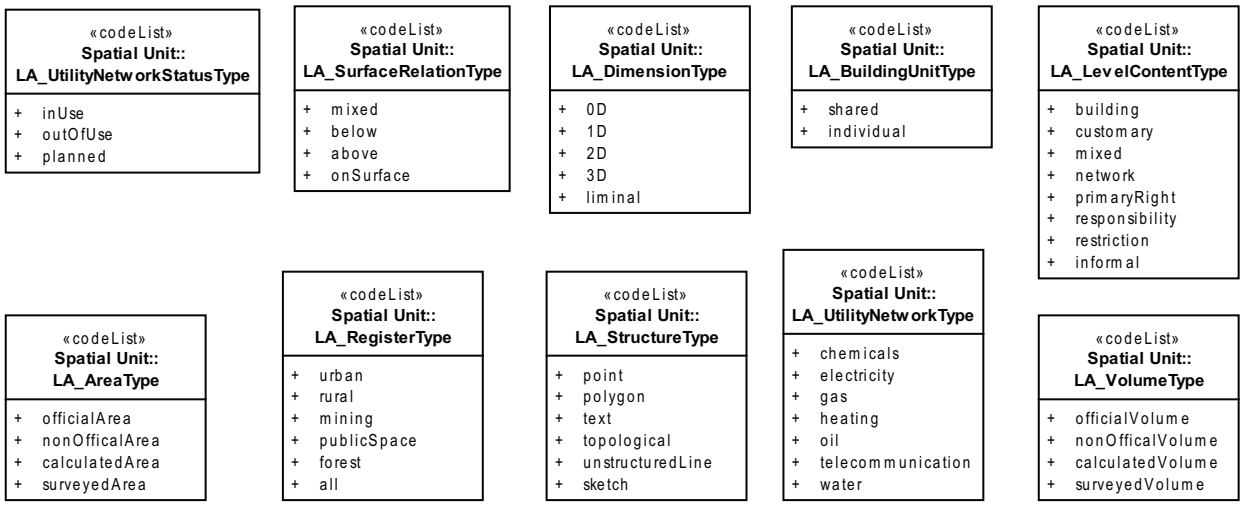


Figure J.3 — Code lists for Spatial Unit Package

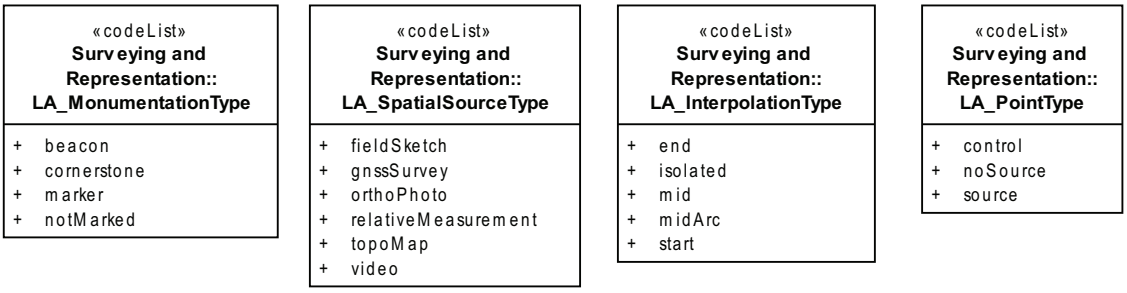


Figure J.4 — Code lists for Surveying and Representation Subpackage

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 the LADM. However, the LADM provides stereotype classes for these data sets, which indicate what data set elements the LADM expects from these external sources, if available.

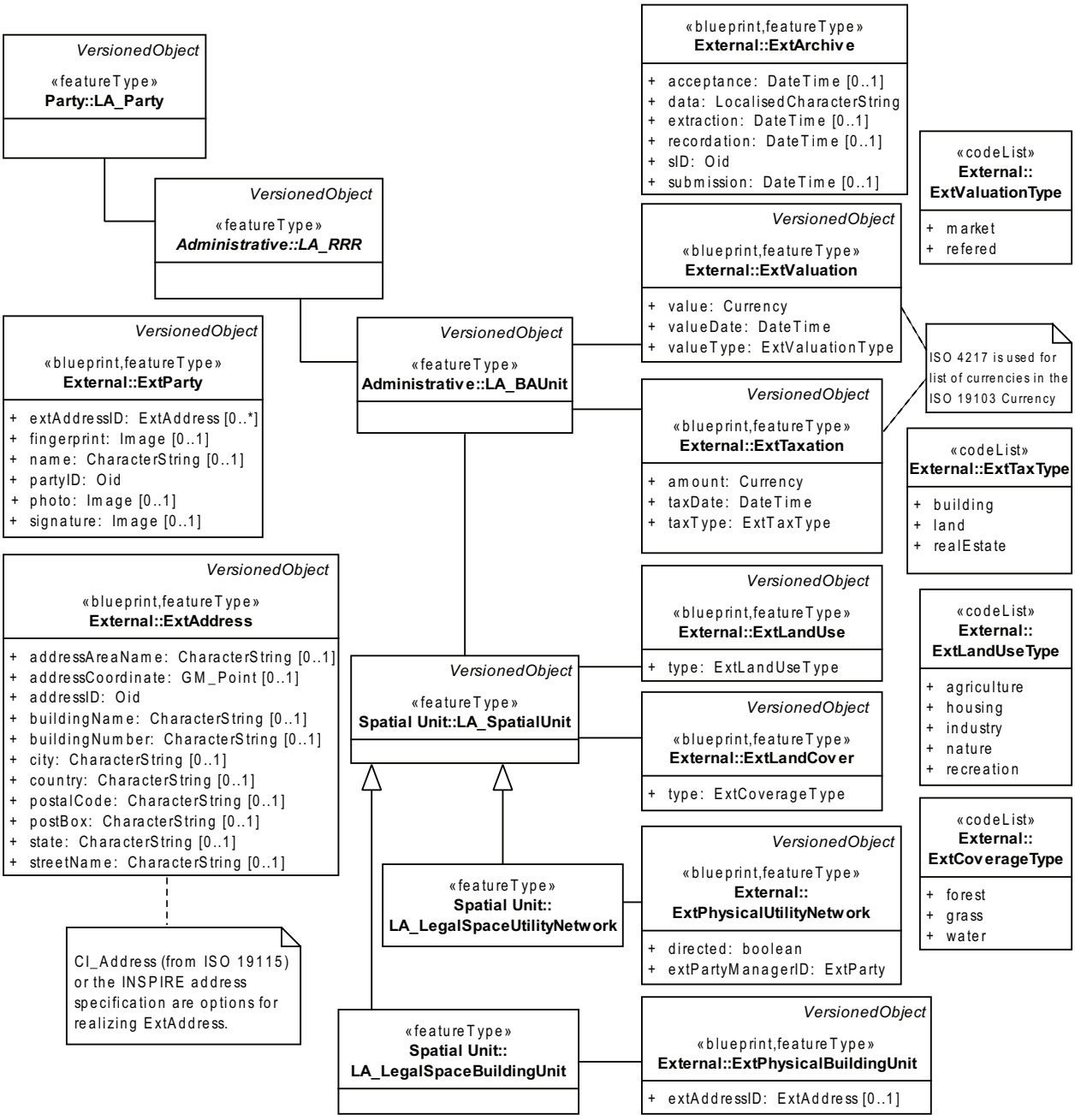


Figure K.1 — External LADM classes

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 a 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.

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 types, 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.

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 ExtPhysicalBuildingUnit

Class ExtPhysicalBuildingUnit is a class for the external registration of mapping data of building units. ExtPhysicalBuildingUnit is associated to class LA_LegalSpaceBuildingUnit, see Figure K.1.

The attribute of ExtPhysicalBuildingUnit is:

— extAddressID: the identifier, pointing to the external address;

K.10 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;

— extraction: the date the source was consulted;

— 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.11 Code lists for external classes

Figure K.2 shows code lists for external classes.

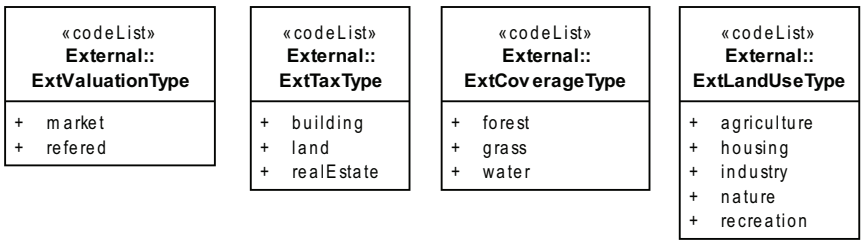


Figure K.2 — The LADM code lists for external classes

Annex L
(informative)

Interface classes

Interface classes can be added to the 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 the 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).

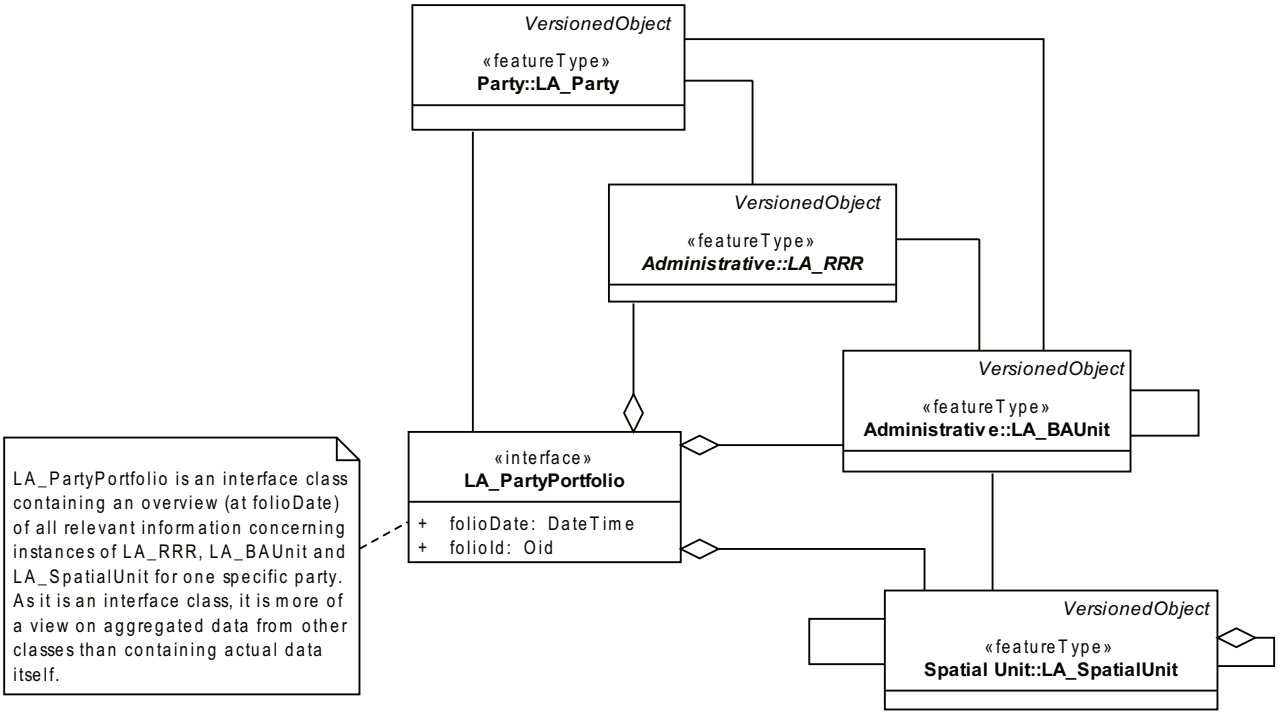


Figure L.1 — Interface class for parties

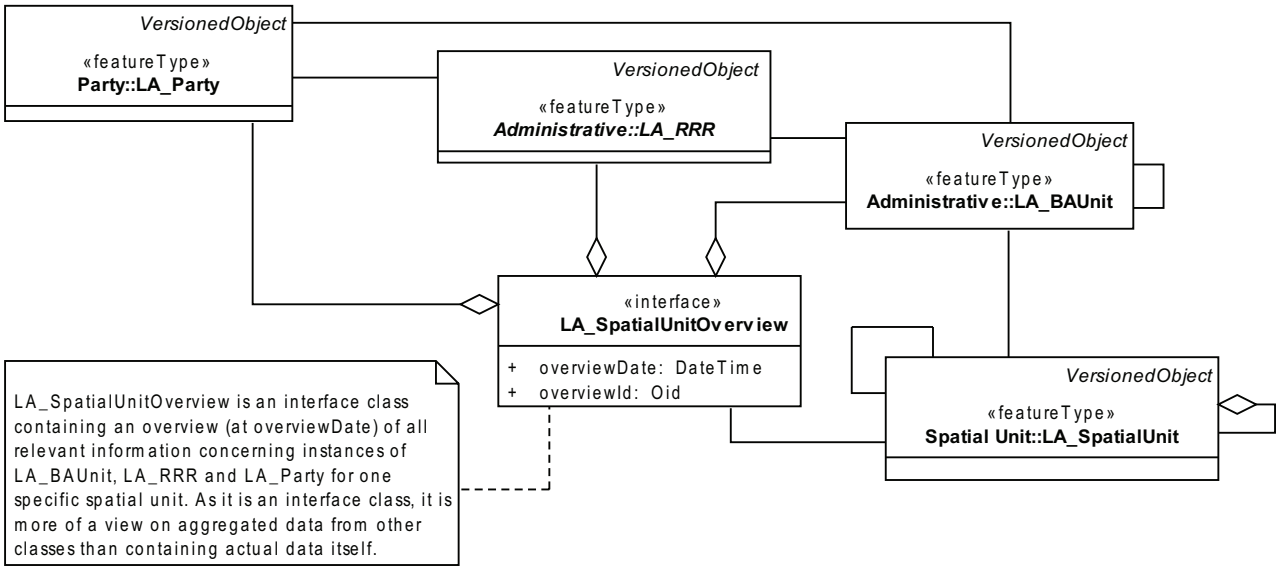


Figure L.2 — Interface class for spatial units

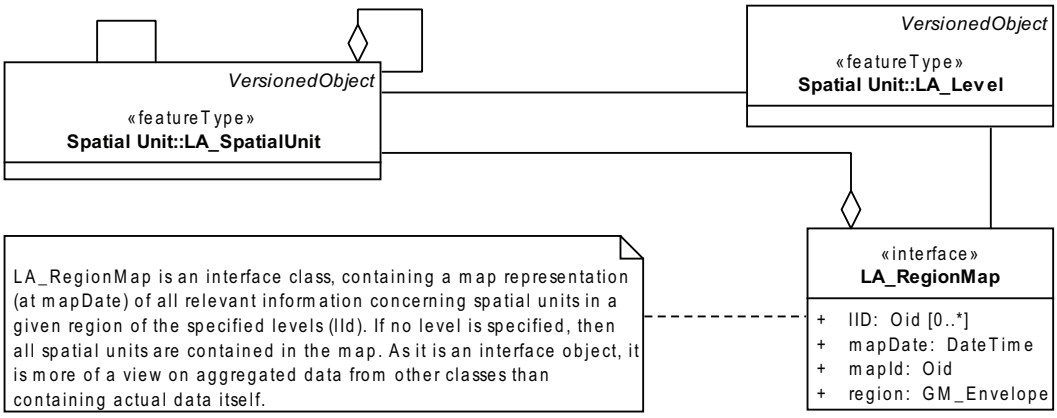


Figure L.3 — Interface class for mapping spatial units

Annex M
(informative)

Modelling land administration processes

Besides the data modelling aspect of the dynamic processes, the LADM provides support for investigating how functions and processes are related to each other. The UML class diagrams will 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.

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

Annex O
(informative)

LADM and other ISO/TC 211 international standards

In this Annex, a number of concepts and classes from other ISO international standards in geographic information (as used in this International Standard) are explained, e.g. GM_Point from ISO 19107, Coordinate Reference Systems from ISO 19111, OM_Observation from ISO 19156 and DQ_Element from ISO 19115. The class GM_Point may look simple at first sight, but it is the start of quite a larger part of the model where relevant LA functionality is available; including support of embedded Coordinate Reference System (CRS). The GM_Point itself is a type (class) that inherits from the abstract class GM_Primitive, which in turn inherits from the abstract class GM_Object, see Figure O.1. Out of these three classes only the class GM_Point has an attribute of type (class) DirectPosition. All three classes define several (generic) operations. The class DirectPosition has one attribute called coordinate of type Sequence<Number> and one derived attribute called dimension of type Integer. Both GM_Object and DirectPosition have an association to the class SC_CRS (Coordinate Reference System) as defined in ISO 19111. Both associations have multiplicity 0..1 at the side of SC_CRS.

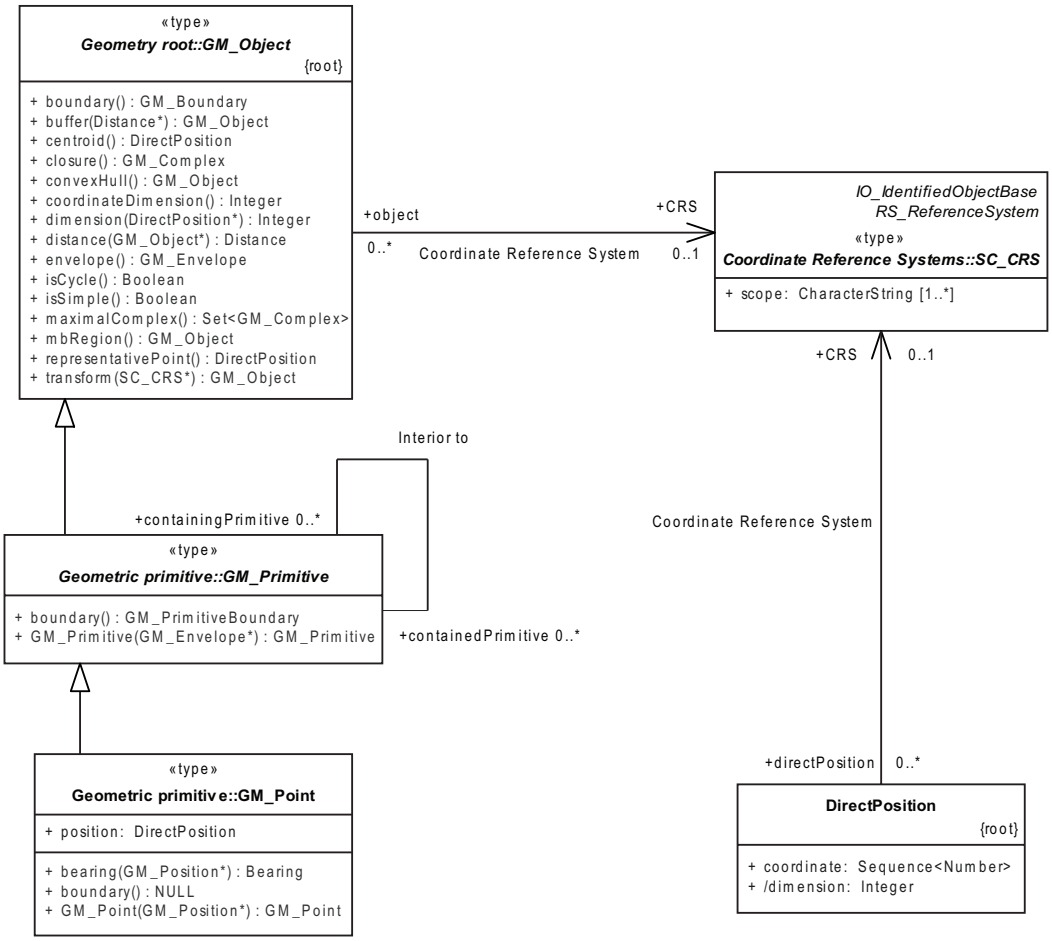


Figure O.1 — The GM_Point (ISO 19107) itself is a type (class) that inherits from the abstract class GM_Primitive, which in turn inherits from the abstract class GM_Object

The abstract class SC_CRS (Coordinate Reference System) has two specializations: the classes SC_SingleCRS (again abstract, with several concrete subclasses, e.g. SC_VerticalCRS, SC_GeodeticCRS, SC_ProjectedCRS) and SC_CompoundCRS (abstract, an aggregation of SC_SingleCRS), see Figure O.2. A SC_SingleCRS is associated with one CS_CoordinateSystem, which has in turn one or more CS_CoordinateSystemAxis, see Figure O.3. In summary, GM_Point and SC_CRS are part of a non-trivial model, which should be able to provide all the functionality needed in the context of LADM and the Survey part, supporting various coordinate systems and transformations.

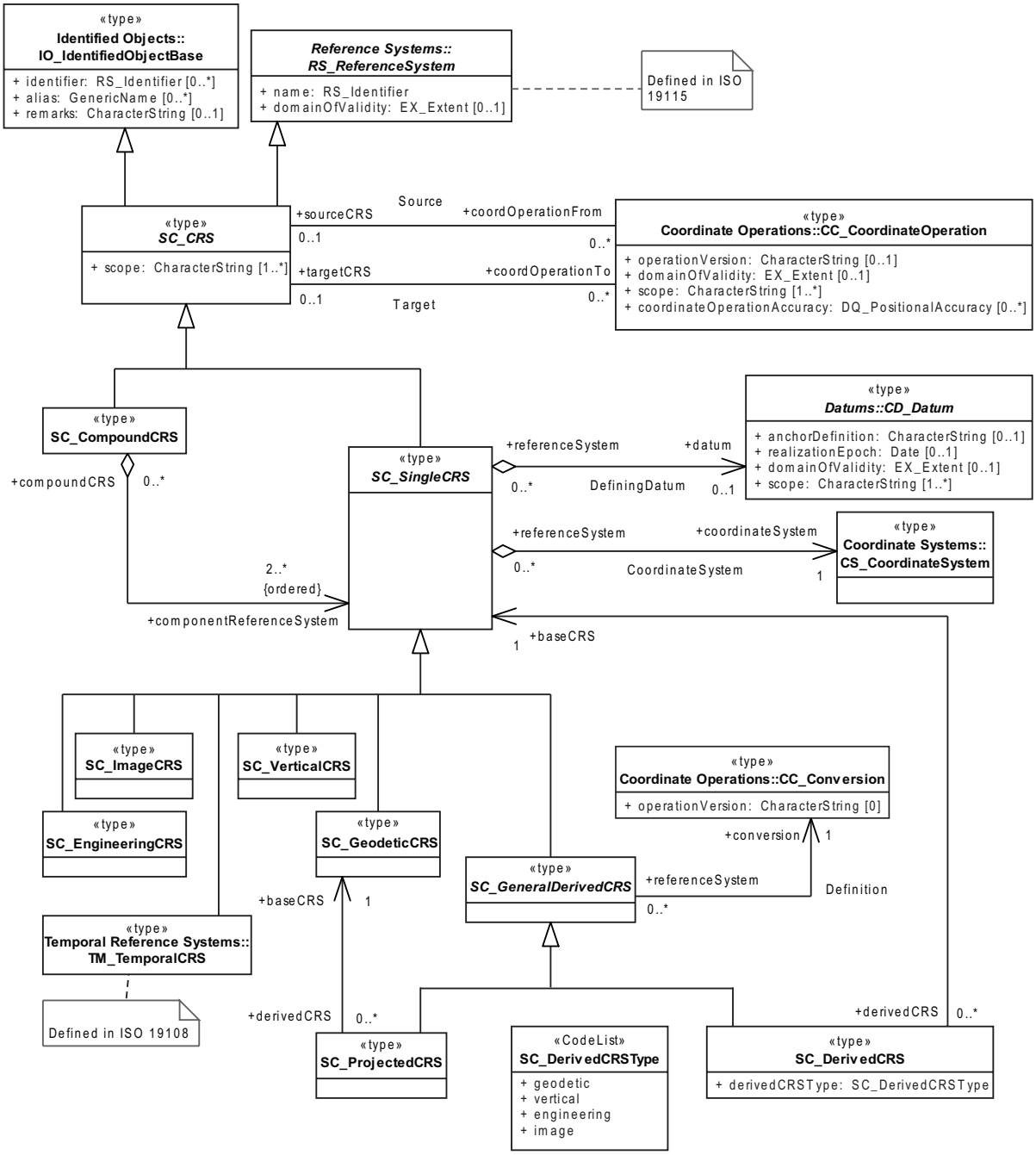


Figure O.2 — The abstract class SC_CRS (Coordinate Reference System) from ISO 19111

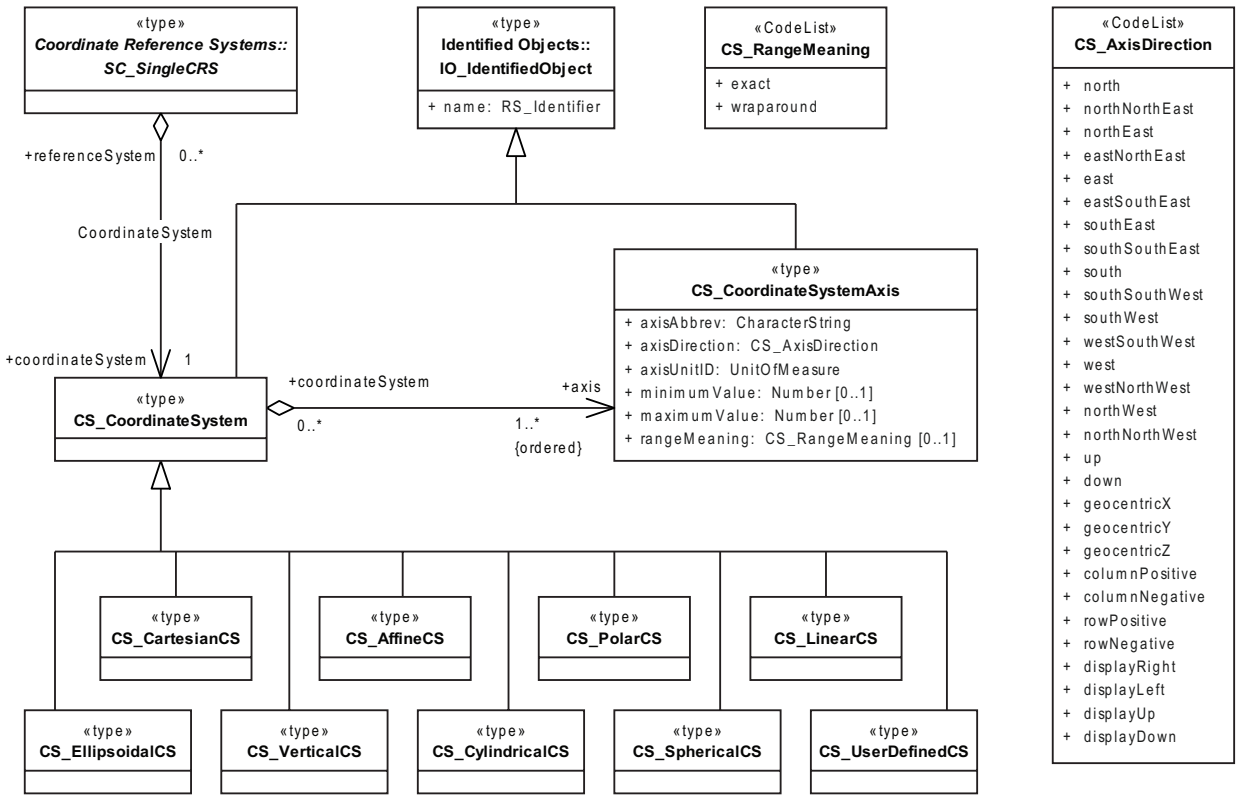


Figure O.3 — SC_CoordinateSystem (from ISO 19111)

Another important ISO international standard in geographic information used in this International Standard is ISO 19156. The survey source data is modeled and stored in LA_SpatialSource. The attribute “measurements” is of type OM_Observation (as defined in ISO 19156) and contains the actual source survey data. The attribute “procedure” is of type OM_Process[1)] and documents the actual survey procedure. The class OM_Observation contains, in addition to the survey data, also attributes for documenting the temporal and quality aspects of the survey; see Figure O.4.

1) Also as defined in ISO 19156:2011: “An instance of OM_Process is often an instrument or sensor, but may be a human observer, a simulator, or a process or algorithm applied to more primitive results used as inputs. NOTE: ISO 19115-2:2009 provides MI_Instrument, LE_Processing and LE_Algorithm, which could all be modelled as specializations of OM_Process. OGC SensorML provides a model which is suitable for many observation procedures."

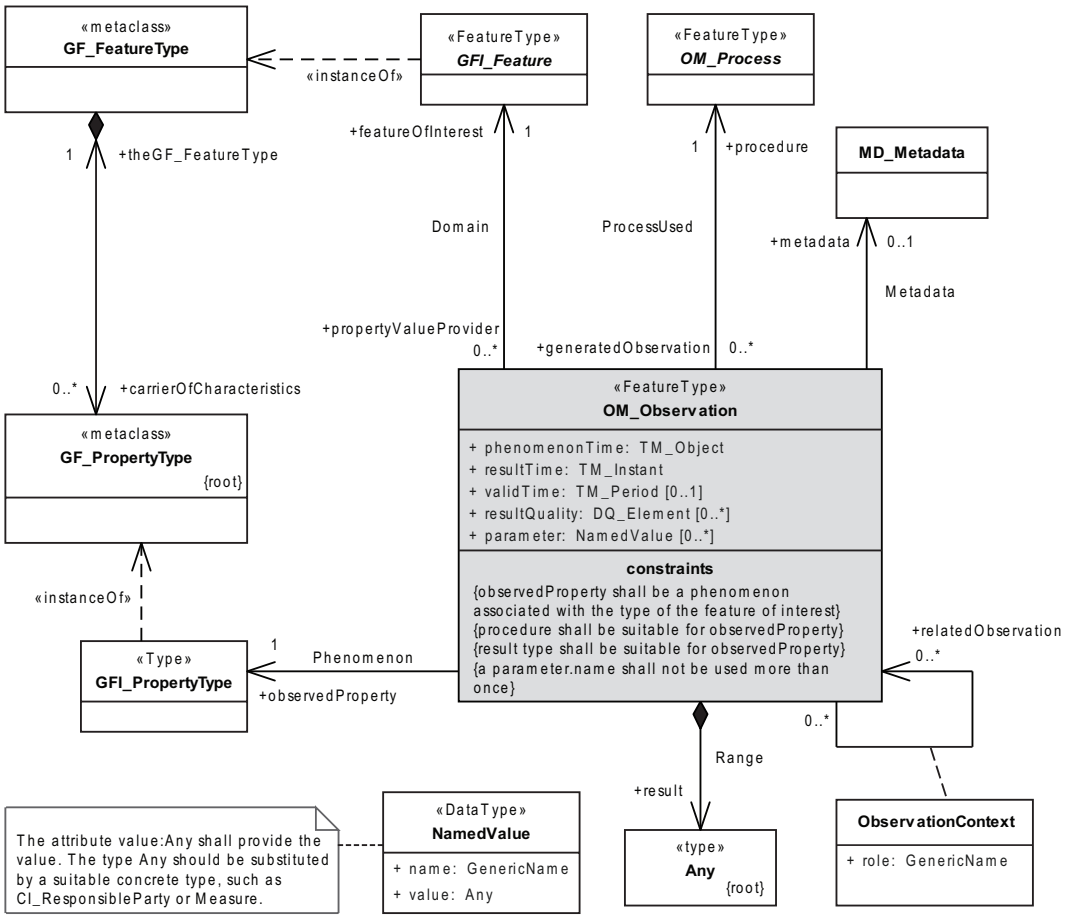


Figure O.4 — OM_Observation (from ISO 19156, Note TM_Instant and TM_Period both from ISO 19108)

The class LA_Point inherits of the abstract class VersionedObject. Besides temporal attributes this also provides attributes for quality (of type DQ_Element) and source (CI_ResponsibleParty, this is the responsible organization of a specific instance version in the database). The quality attribute has multiplicity 0..* and so the various quality aspects as modelled via DQ_Element can be represented. DQ_Element is class from ISO 19115:2003. It is an abstract class with the following subclasses: DQ_Completeness, DQ_LogicalConsistency, DQ_ThematicAccuracy, DQ_TemporalAccuracy, and DQ_PositionalAccuracy, see Figure O.5. The source attribute also has multiplicity 0..* and the class CI_ResponsibleParty is also from ISO 19115:2003. Besides a number of names (individual, organization, positional) the role and contact information of the responsible party is also modeled, see Figure O.6.

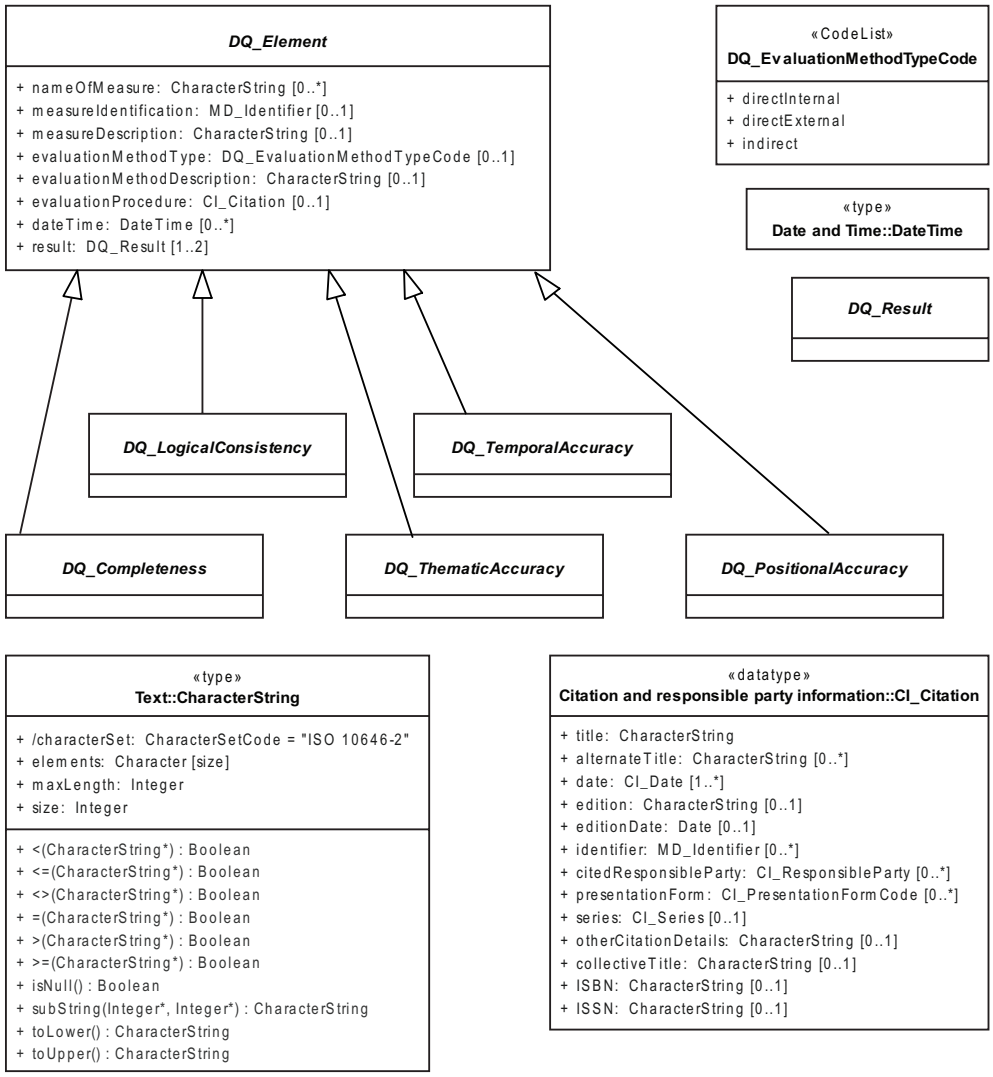


Figure O.5 — DQ_Element (from ISO 19115)

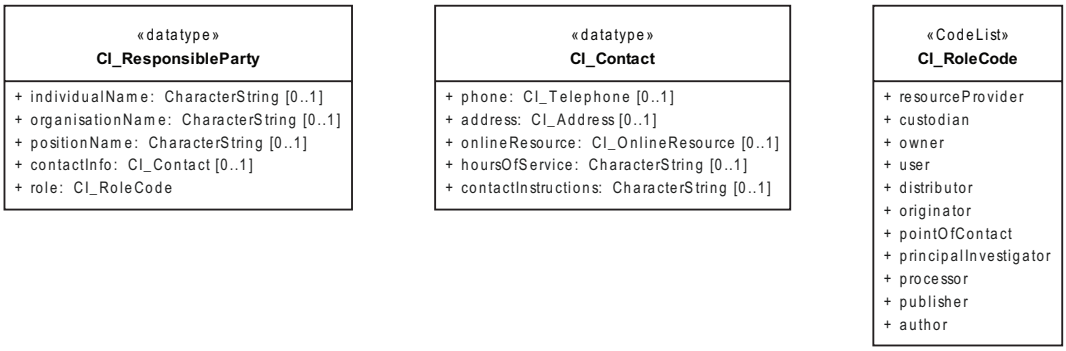


Figure O.6 — CI_ResponsibleParty (from ISO 19115)

Bibliography

[1] ARKO-ADJEI, A. (2006). *Conceptual Approach for Enhancing Customary Land Management: Case from Ghana*. In: Proceedings of the 5th FIG Regional Conference: Promoting Land Administration and Good Governance, 8-11 March, Accra, Ghana. Available at <http://www.fig.net/pub/accra/papers/ts05/ts05_04_arkoadjei.pdf>

[2] AUGUSTINUS, C., C.H.J. LEMMEN and P.J.M VAN OOSTEROM, (2006). *Social Tenure Domain Model — Requirements from the perspective of pro-poor land management*, 5th FIG Regional Conference - Promoting Land Administration and Good Governance, 8-11 March, Accra, Ghana

[3] CCM (2009). *Core Conceptual Model for Land Parcel Identification System (LCM): technical specification. European Commission*, DG JRC – Ispra, Institute for the Protection and Security of the Citizen, Monitoring of Agricultural Resources Unit. Available at <http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Core-Conceptual-Model-for-Land-Parcel-Identification-System-LCM>

[4] INAN, H.I., W. DEVOS, P. MILENOV, P.J.M. VAN OOSTEROM, V. SAGRIS and J.A. ZEVENBERGEN, (2008). *Data model for the collaboration of LASs and IACS/LPISs*. Workshop LPIS Applications and Quality, 17-18 September, Sofia, Bulgaria

[5] INSPIRE (2007).Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). Available at <http://inspire.jrc.ec.europa.eu/>

[6] INSPIRE (2009). D2.8.I.6 *INSPIRE Data Specification on Cadastral Parcels – Guidelines*. 2009-09-07. Available at <http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_CP_v3.0.pdf>

[7] ISO 19106:2004, *Geographic Information — Profiles*

[8] ISO 19109:2005, *Geographic information — Rules for application schema*

[9] ISO 19110:2005, *Geographic information — Methodology for feature cataloguing*

[10] ISO 19126:2009, *Geographic information — Feature concept dictionaries and registers*

[11] ISO 19131:2007, *Geographic information — Data product specifications*

[12] ISO 19132:2007, *Geographic information — Location-based services — Reference model*

[13] ISO 19153:—[2], *Geospatial Digital Rights Management Reference Model (GeoDRM RM)*

[14] KAUFMANN, J. and D. STEUDLER, (1998). *Cadastre 2014. A vision for a future cadastral system*, FIG-Commission 7, July, Brighton, U.K. Available at <http://www.fig.net/cadastre2014/translation/c2014-english.pdf>

[15] KAUFMANN, J. (2004). *ArcGIS Cadastre 2014 Data Model Vision*. Redlands, CA, USA, ESRI: pp 62

[16] LEMMEN, C. H. J. and P. J. M. VAN OOSTEROM, (2006). Version 1.0 of the FIG Core Cadastral Domain Model. FIG XXIII International Congress. Munich, Germany

2) To be published.

[17] LENGOIBONI, M., A.K. BREGT and P. VAN DER MOLEN, (2010). *Pastoralism within land administration in Kenya - The missing link*. Land Use Policy 27, pp. 579-588

[18] MEIJERS, M. (2011). *Variable-scale Geo-information*, Phd thesis, 235 pp. TU Delft, the Netherlands

[19] PAASCH, J.M. (2005). *A legal cadastral domain model - An object-oriented approach,* Nordic Journal of Surveying and Real Estate Research, **2** (1), pp. 117-136. Available at <http://ojs.tsv.fi/index.php/njs/article/view/1679/1526>

[20] SAGRIS, V. and W. DEVOS, (2008). LPIS *Core Conceptual Model: methodology for feature catalogue and application schema*, GeoCAP Discussion Paper, European Commission, DG JRC – Ispra, Institute for the Protection and Security of the Citizen, Agriculture Unit. Available at <http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/LPIS-Core-Conceptual-Model>

[21] STOTER, J.E. (2004). *3D cadastre*, PhD thesis, 327 pp, TU Delft, The Netherlands

[22] THOMPSON, R. (2008). Illustrations made by Rod Thompson, after discussion following the ISO/PT 19152 September 2008 meeting in Delft, The Netherlands

[23] UN/ECE (1996). *United Nations/Economic Commission for Europe, Land administration guidelines with special reference to countries in transition*, Geneva, Switzerland

[24] UN/ECE (2004). *United Nations/Economic Commission for Europe, Guidelines on real property units and Identifiers – and their importance in supporting effective national land administration and land management*, Geneva, Switzerland

[25] UN/ECE (2006). *United Nations/Economic Commission for Europe, Land administration guidelines*, Geneva, Switzerland

[26] UN-HABITAT (2009). *Country activities report 2009*. Available at <http://www.unhabitat.org>

[27] VAN OOSTEROM, P.J.M. and C.H.J. LEMMEN, (2001). *Spatial Data Management on a very large cadastral database*, Computers, Environment and Urban Systems', Theme Issue 'Cadastral Systems', **25** (4-5), pp. 509-528

[28] VAN OOSTEROM, P.J.M. and C.H.J. LEMMEN, (2002). *Impact analysis of recent Geo-ICT developments on cadastral systems*. FIG XXII International Congress. Washington, D.C., USA

[29] VAN OOSTEROM, P.J.M., C.H.J. LEMMEN, T. INGVARSSON, P. VAN DER MOLEN, H. PLOEGER, C.W QUAK, J.E. STOTER, and J.A. ZEVENBERGEN, (2005). *The core cadastral domain model,* Computers, Environment and Urban Systems, **30** (5), pp. 627-660

[30] WG-CPI (2006). *Role of the cadastral parcel in INSPIRE and national SDIs with impacts on cadastre and land registry operations*. Joint Working Group of EuroGeographics and the PCC (WG-CPI), Inventory document. Available at <http://www.eurocadastre.org/pdf/inventory_cadastral_parcel_28_02_2006.doc>

[31] ZEVENBERGEN, J.A. (2004). *Expanding the legal/administrative package of the Cadastral Domain Model – from grey to yellow?*, Proceedings of the Workshop Standardization in the Cadastral Domain, 9-10 December, Bamberg, Germany, pp. 139-144

ICS 35.240.70

Price based on 118 pages