Form 36

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000
Fax: +44 (0)20 8996 7400
www.bsigroup.com

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Direct tel: 020 8996 7009
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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex **(e.g. 3.1)**	Paragraph/ Figure/Table/Note	**Type of comment**	**Commend (justification for change) by the MB**	**Proposed change by the MB**	**Secretariat observations on each comment submitted**
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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ISO/TC **211**

Secretariat: **SIS**

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Geographic information — Land Administration Domain Model (LADM) —

Part 2: Land registration

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

Partie 2: Enregistrement foncier

ICS: 35.240.70

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This edition of ISO 19152-2 together with ISO 19152-1 cancel and replace the first edition (ISO 19152:2012), which has been technically revised.

The main changes are as follows:

— This version of ISO 19152-2 defines the fundamental terms, basic components, relationships, attributes and constraints for land registration. A detailed overview of the model has been presented in its individual packages.

— The terms, although unchanged in principle, have been defined more rigorously (i.e., administrative source, liminal spatial unit), enriched with examples and notes. Updates in ISO/TC 211 standards (i.e., definitions, data types) have been reflected, and corresponding adjustments have been made where necessary.

— Requirements that a land registration system can conform been formulated in contrast to ISO 19152:2012. It is noted that the use of 'shall' only in requirements statements is mandatory according to ISO rules.

— While 3 new (featureType) classes different from ISO 19152:2012 have been introduced in ISO 19152-1 (i.e., LA_RequiredRelationshipRRR, LA_LegalSpaceCivilEngineeringElement, LA_LegalSpaceParcel), 13 new (featureType) classes different from ISO 19152:2012 have been introduced in ISO 19152-2 (i.e., LA_SurveySource, LA_DesignSource, LA_SurveyRelation, LA_DistanceObservation, LA_LevelObservation, LA_AngularObservation, LA_ImageObservation, LA_TPSObservation, LA_PointCloudObservation, LA_GNSSObservation, LA_GNSSCorrection, LA_GPRObservation, LA_MBESObservation). No (featureType) classes have been removed from 19152:2012.

— The surveying and representation subpackage have been refined with types of observation information, such as distance, level, angular, image, TPS, point cloud, GNSS and GPR.

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— In order to support all types of spatial units two new subclasses for LA_SpatialUnit have been introduced in ISO 19152-2: LA_LegalSpaceCivilEngineeringElement and LA_LegalSpaceParcel. An optional geometry attribute has been added to LA_SpatialUnit.

— The LA_LegalSpaceUtilityNetwork (featureType) class has been renamed to LA_LegalSpaceUtilityNetworkElement. LA_UtilityNetworkType code list has been renamed to LA_UtilityNetworkElementType.

— In order to represent topological relationships between spatial units, two new (dataType) classes (i.e., TopoRelation and IntersectionPatternMatrix) have been created based on the definition given in 19107:2019 and have been introduced in ISO 19152-2. In addition, 3 code lists (i.e., TopoRelationType, DimensionExtension and SetMask) have been created based on the definition given in 19107:2019 and have been introduced in ISO 19152-2.

— Only one multiplicity of an association has been changed: A point may now be associated to zero or more [0..*] spatial units, not [0..1] spatial unit.

— The Annex I (informative) – Social Tenure Domain Model (STDM) of ISO 19152:2012 has been refined and moved to the Annex B (formative) of ISO 19152-2.

— Annex A (normative) – Abstract Test Suite has been redesigned using the requirements introduced the main part of ISO 19152-2.

— Annex C (informative) – 2D and 3D Representations of Spatial Units has been refined and extended in order to support all types of spatial unit representation.

— Annex G (informative) – Code Lists has been refined and extended to support semantically enriched code list values. Generic definitions for code list values have been provided. Existing code lists have been refined with new values and 24 new code lists have been introduced (i.e., LA_CivilEngineeringType, LA_ParcelUseType, LA_SurveyPurposeType, LA_AutomationLevelType, LA_PlatformType, LA_SurveyMethodType, LA_ObservationsAccuracyType, LA_LifecyclePhaseType, LA_DesignFileCreatorRoleType, LA_DesignObjectType, LA_SourceFileType, LA_SpatialTransactionType, LA_DistanceType, LA_AngleType, LA_SatelliteSystemType, LA_GNSSSurveyType, LA_GNSSReferenceStationsNetworkType, LA_GNSSReferenceStationsNetworkScale, LA_CorrectionServiceType, LA_GNSSFrequencyType, LA_SSR_Error_Components, TopoRelationType, DimensionExtension and SetMask) in ISO 19152-2.

— Annex H (informative) – The LADM and LPIS, Annex M (informative) – Modelling land administration processes and Annex N (informative) – History and dynamic aspects of ISO 19152:2012 have not been included in ISO 19152-2. Annex K (informative) – LADM and IndoorGML and Annex L (informative) – LADM and legal spaces in buildings have been introduced in ISO 19152-2. All the other not mentioned annexes has been updated and refined.

— The bibliography has been revised to include additional references and has been reformatted.

A list of all parts in the ISO 19152 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document 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 / geo-regulation is a large field; the focus of this document is on that part of land administration that is interested in rights, responsibilities and restrictions affecting land, and the geometrical (geospatial) components thereof. The LADM provides a reference model which will serve two goals:

a) 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

b) 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 and international context, where land administration / geo-regulation domain semantics have to be shared between regions, or countries, in order to enable necessary translations. Four considerations during the design of the model were:

— it will cover the common aspects of land administration / geo-regulation worldwide;

— it will be based on the conceptual framework of 'Cadastre 2014' of the International Federation of Surveyors (FIG);

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

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

The first edition of this standard, ISO 19152:2012 concentrated on Land Administration, Land Registration and Cadastre. This information is about the relationship between people and land. This is now included in Part 2 with a more refined survey model, namely by this standard. Part 1 of this standard provides the general reference model for all aspects of regulation in a geospatial environment. Part 3 is Marine georegulation, Part 4 Valuation information and Part 5 Spatial plan information. Part 6 provides an overview of relevant aspects in implementations.

Until now, most countries (or states, provinces) have developed their own Land Administration System. Some systems are centralized, and others decentralized, while some 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 facilitate meaningful communication across borders. 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:

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

ii) 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, then it can be viewed as a type of 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

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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, BIM 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 and generally referred to as parties), classification of land use, land value, map representations of spatial units, and so on. Computerized systems require further standardization when topology and the identification of single boundaries are introduced. In existing land administration systems 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 document is provided in Clause 1. Conformance in relation to this document 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 provides the notation and context. Clause 6 gives a global overview of packages. Clause 7 introduces the classes, attributes and associations in detail. Annex B gives an overview of Social Tenure Domain Model (STDM). Annex C explains the 2D and 3D representations of spatial units, spatial unit profiles and refined survey model. A comprehensive set of informative examples (using instance level cases) is available in Annex D.

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. Code list values in the main text are informative (not normative) and can only be considered as examples. Specific parts of the LADM are further detailed in the legal profiles in Annex E. Some examples of using the LADM in a specific context are: the INSPIRE cadastral parcels in Annex F. It is possible to use only a subset, or profile, of the LADM for a specific implementation. Annex G presents the LADM code lists as a basis for describing a flexible enumeration, and gives an overview of semantic technologies for representing code list values.

The construction of external databases with party data, address data, taxation data, land cover 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 H. Interface classes are in Annex I. Annex J explains the link to other ISO international standards. Annex K presents a framework for the integration of the LADM and IndoorGML. Annex L proposes a framework for representing legal spaces in building.

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Geographic information — Land Administration Domain Model (LADM) —

Part 2: Land registration

1 Scope

This document:

a) defines a reference Land Administration Domain Model (LADM) covering basic information-related components of Land Administration (including elements above and below the surface of the earth);

b) provides an abstract, conceptual model with three packages and one sub-package related to

   1) parties (people and organizations) [19152-2];

   2) basic administrative units, rights, responsibilities, and restrictions (ownership rights) [19152-2];

   3) spatial units (parcels, and the legal space of buildings and utility networks and other geometry) with a sub-package on surveying and spatial representation (geometry and topology) [19152-2];

c) 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;

d) provides a platform for comparison and monitoring that is based on indicators;

e) provides a basis for national and regional profiles; and

f) enables the combination of land administration information from different sources in a coherent manner.

The following is outside the scope of this document:

— interference with (national) land administration laws that may have any legal implications; and

— construction of external databases with party data, address 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.

This document provides the concepts and the detailed structure for standardization in the land administration domain.

2 Normative references

The following documents are referred to in the main text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 5218:2022, *Information technology — Codes for the representation of human sexes*

ISO 19103:2015, *Geographic information — Conceptual schema language*

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ISO 19105:2022, *Geographic information — Conformance and testing*

ISO 19107:2019, *Geographic information — Spatial schema*

ISO 19109:2015, *Geographic information — Rules for application schema*

ISO 19111:2019, *Geographic information — Referencing by coordinates*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19152-1:2024, *Geographic information — Land Administration Domain Model (LADM) — Part 1: Generic conceptual model*

ISO 19156:2023, *Geographic information — Observations, measurements and samples*

OGC *Land and Infrastructure Conceptual Model Standard (LandInfra)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19152-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
administrative source
<LADM> source comprised of the administrative description (where applicable) of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected

EXAMPLE 1 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.

3.1.2
boundary
set that represents the limit of an entity

Note 1 to entry: 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.

[SOURCE: ISO 19107:2019, 3.6]

3.1.3
boundary face
face that is used in the 3-dimensional representation of a boundary of a spatial unit

Note 1 to entry: Boundary faces are used when the implied vertical and unbounded faces of a boundary face string are not sufficient to describe 3D spatial units. Boundary faces close volumes in height (e.g., every apartment floor), or in depth (e.g. an underground parking garage), or in all other directions to form a bounded volume. The volumes represent legal space (in contrast with physical space).

[SOURCE: ISO 19152-1:2024, 3.22]

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3.1.4
boundary face string
boundary forming part of the outside of a spatial unit

Note 1 to entry: Boundary face strings are used to represent the boundaries of spatial units by means of linestrings in 2D. This 2D representation is a 2D boundary in a 2D land administration system. In a 3D land administration system, it represents a series of vertical boundary faces where an unbounded volume is assumed, surrounded by boundary faces which intersect the earth's surface (such as traditionally depicted in the cadastral map).

3.1.5
face
<topology> 2-dimensional topological primitive

Note 1 to entry: 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.

[SOURCE: ISO 19107:2019, 3.38]

3.1.6
level
<LADM> set of spatial units, with a geometric, and/or topologic, 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 associated with rights and another level of spatial units to define basic administrative units associated with restrictions.

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 based spatial units, a second level with line based spatial units, and a third level with polygon based spatial units.

3.1.7
liminal spatial unit
<LADM> spatial unit with a geometry represented as a combination of boundary face strings (2D) and boundary faces (3D)

Note 1 to entry: A liminal spatial unit is represented by a spatial unit on the threshold between 2D and 3D representations.

3.1.8
point
0-dimensional geometric primitive, representing a position

Note 1 to entry: The boundary of a point is the empty set.

Note 2 to entry: A point may be used to define one or more boundary faces or boundary face strings.

Note 3 to entry: Points can be observed by e.g., terrestrial surveying, but also by photo interpretation, image interpretation, or identification on an existing map.

[SOURCE: 19136-1:2020, 3.1.47, modified —Note 2 and 3 to entry to entry have been added.]

3.1.9
utility network
<LADM> network describing the legal space of the topology of a utility

EXAMPLE The legal space needed to locate and maintain the network.

Note 1 to entry: A utility network may be attributed with information about its legal, recorded or informal space.

Note 2 to entry: A utility network can also be modelled as a basic administrative unit.

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3.2 Abbreviations

BAUnit	Basic Administrative Unit
FIG	International Federation of Surveyors
GNSS	Global Navigation Satellite System
GPR	Ground-penetrating radar
IHO	International Hydrographic Organization
INSPIRE	Infrastructure for Spatial Information in Europe
LA	Land Administration
LAS	Land Administration System
LADM	Land Administration Domain Model
MBES	Multibeam Echosounder
OGC	Open Geospatial Consortium
RRR	Right, Restriction, Responsibility
SDI	Spatial Data Infrastructure
STDM	Social Tenure Domain Model
TPS	Terrestrial Positioning System
UML	Unified Modelling Language

4 Conformance

4.1 Conformance requirements and testing

Conformance to this part of the ISO 19152 series on Land Administration Domain Model (LADM) (Part 2 – Land registration) consists of alignment with the requirements established in Clauses 4.2 and 7 in this document. The Abstract Test Suite given in Annex A describes a methodology for testing conformance to these requirements.

4.2 Conformance classes

1) **'Based on Generic Conceptual Model'**

   https://standards.isotc211.org/19152/-2/1/req/basedongenericconceptualmodel

Requirement 1: This part of the standard is based on Part 1 – Generic Conceptual Model. All requirements contained in 19152-1 shall apply to this part of the standard.

2) **'Continuum of Rights'**

   https://standards.isotc211.org/19152/-2/1/req/continuumofrights

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Requirement 2: The continuum of land rights shall be supported. This includes the recognising, recording, administering a variety of appropriate and legitimate land tenure forms, such as registered freehold, lease, group tenure, adverse possession, occupancy, customary.

3) **'Grouping People Land'**

https://standards.isotc211.org/19152/-2/1/req/groupingpeopleland

Requirement 3: Groupings of people and land shall be supported. The flexibility of LA model can be based on the recognition that people to land relationships appear in many different ways, depending on local tradition, culture, religion and behaviour.

4) **'Different Organisations'**

https://standards.isotc211.org/19152/-2/1/req/differentorganisations

Requirement 4: LA data can be maintained by different organisations. And within one organisation at many sites. Administrative territories for organisations can be completely different. The LADM based systems shall be implemented as a distributed set of (geo-) information systems, each supporting the maintenance processes (transactions in land rights, establishment of rights, restrictions and responsibilities) and the information supply of parts of the data set, represented in this model.

5) **'Keep Data to Source'**

https://standards.isotc211.org/19152/-2/1/req/keepdatatosource

Requirement 5: LA data shall be kept to the source within Spatial Data Infrastructure (SDI). Today all data (spatial and thematic) can be stored in a Data Base Management System (DBMS). Information products are becoming flexible combinations of digital data components and additional facilities and services. This can replace the exchange of copies of data sets between organisations. Multi source information products require avoidance of redundancy and good standardisation protocols.

5 Notation

The conceptual schema specified in this part of ISO 19152 is described using the Unified Modelling Language (UML), following the guidance of ISO 19103:2015.

Several model elements used in this schema are defined in other ISO geographic information standards. By convention within some ISO/TC 211 standards, names of UML classes, with the exception of basic data type classes, include a two-letter prefix that identifies the standard and the UML package in which the class is defined. This provides a global unique name for the class. UML classes defined in this part of ISO 19152 have the two-letter prefix of LA. Table 1 lists the prefixes as defined for some of the other parts of ISO 19152. Same prefix is used for Part 1 and Part 2 to support backward compatibility. Table 2 lists the prefixes used by LADM.

Table 1 — Sources of internally defined UML classes

Prefix	Standard	Part
LA	19152-1	Generic conceptual model
LA	19152-2	Land registration
MG	19152-3	Marine georegulation
VM	19152-4	Valuation information
SP	19152-5	Spatial plan information

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Table 2 — External sources used by LADM

Prefix	Standard	Part
CI, LI	19115-1	Metadata Part 1: Fundamentals
OM	19156	Observations and measurements

6 Overview of the LADM conceptual information model

6.1 General

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 (national, regional or local). 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.

The standards addressing land administration and geo-regulation makes use of the generic General Feature Model as described in ISO standard 19109 Rules for application schema. It describes a feature oriented approach where a feature may have thematic, temporal, spatial, quality, etc. attributes. The spatial geometries derive directly from this structure.

6.2 Packages and subpackages of the LADM

The LADM is organized into a set of packages, and subpackages (see Figure 1). 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.

LADM Part 1 – Generic conceptual model and LADM Part 2 – Land registration together form an application schema. Figure 1 shows all classes of Part 1 and Part 2.

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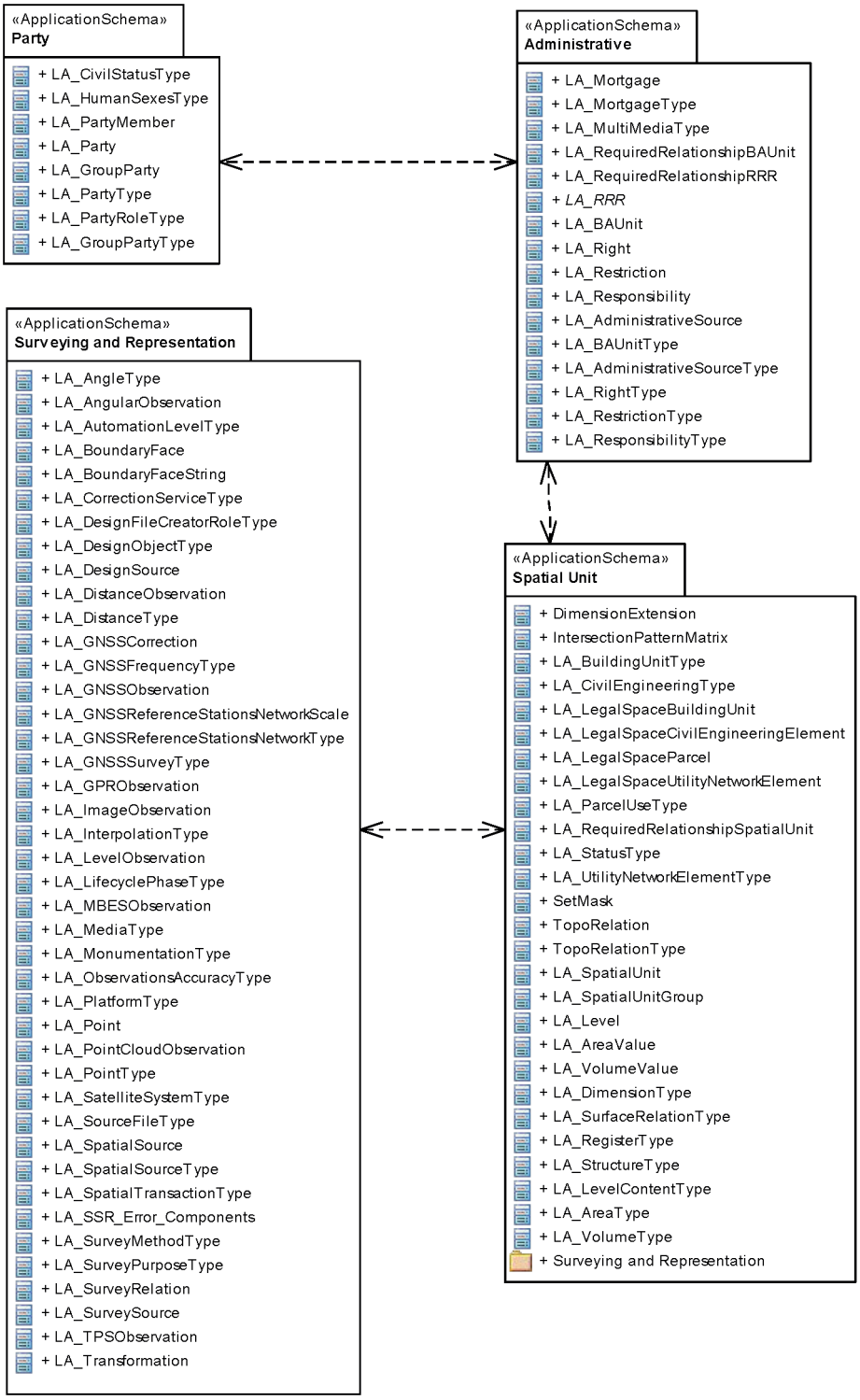


Figure 1 — Packages of the core LADM (with their respective classes)

Table 3 shows which packages and classes are defined in which part of the standard.

Table 4 shows which packages and code lists are defined in which part of the standard.

It is important to note that no attributes are available in Part 1, except for the special classes. This part of the standard gives detailed descriptions about the classes introduced in Part 1 and the classes introduced in this part of the standard. Table 4

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Table 3 — Packages and classes of Part 1 and Part 2

(Sub)Package name	Class name	Defined part
Special classes	LA_Source, VersionedObject, Oid, Fraction	Part 1
	—	Part 2
Party	LA_Party, LA_GroupParty, LA_PartyMember	Part 1
	—	Part 2
Administrative	LA_BAUnit, LA_RRR, LA_Right, LA_Restriction, LA_Responsibility, LA_AdministrativeSource, LA_RequiredRelationshipBAUnit, LA_RequiredRelationshipRRR	Part 1
	LA_Mortgage	Part 2
Spatial unit	LA_SpatialUnit, LA_SpatialUnitGroup, LA_Level, LA_RequiredRelationshipSpatialUnit	Part 1
	LA_LegalSpaceParcel, LA_LegalSpaceBuildingUnit, LA_LegalSpaceUtilityNetworkElement, LA_LegalSpaceCivilEngineeringElement, LA_AreaValue, LA_VolumeValue	Part 2
Surveying and representation	—	Part 1
	LA_Point, LA_BoundaryFace, LA_BoundaryFaceString, LA_SpatialSource, LA_SurveySource, LA_DesignSource, LA_AngularObservation, LA_DistanceObservation, LA_GNSSObservation, LA_GNSSCorrection, LA_GPRObservation, LA_ImageObservation, LA_LevelObservation, LA_MBESObservation, LA_PointCloudObservation, LA_TPSObservation, LA_SSR_Error_Components, LA_Transformation	Part 2

Table 4 — Packages and code lists of Part 1 and Part 2

(Sub)Package name	Code list name	Defined part
Special classes	LA_AvailabilityStatusType	Part 1
	—	Part 2
Party	—	Part 1
	LA_PartyType, LA_PartyRoleType, LA_HumanSexesType, LA_CivilStatusType, LA_GroupPartyType	Part 2
Administrative	—	Part 1
	LA_BAUnitType, LA_AdministrativeSourceType, LA_RightType, LA_RestrictionType, LA_ResponsibilityType, LA_MortgageType, LA_MultiMediaType	Part 2
Spatial unit	—	Part 1
	LA_DimensionType, LA_SurfaceRelationType, LA_RegisterType, LA_StructureType, LA_LevelContentType, LA_AreaType, LA_VolumeType, LA_BuildingUnitType, LA_CivilEngineeringType, LA_ParcelUseType, LA_StatusType, LA_UtilityNetworkElementType, TopoRelation, DimensionExtension, SetMask, TopoRelationType	Part 2
Surveying and representation	—	Part 1
	LA_AngularType, LA_AutomationLevelType, LA_CorrectionServiceType, LA_DesignFileCreatorRoleType, LA_DesignObjectType, LA_DistanceType, LA_GNSSCorrection, LA_GNSSFrequencyType, LA_GNSSReferenceStationsNetworkScale, LA_GNSSReferenceStationsNetworkType, LA_GNSSSurveyType, LA_InterpolationType, LA_LifecyclePhaseType, LA_MediaType, LA_MonumentationType, LA_ObservationsAccuracyType, LA_PlatformType, LA_PointType, LA_SatelliteSystemType, LA_SourceFileType, LA_SpatialSourceType, LA_SpatialTransactionType, LA_SurveyMethodType, LA_SurveyPurposeType	Part 2

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6.3 Basic classes of the LADM

The core LADM is based on six basic classes:

a) Class LA_Source. Instances of this class are sources;

b) Class *VersionedObject*. Instances of subclasses of *VersionedObject* are all LADM classes except for LA_Source.

c) Class LA_Party. Instances of this class are parties;

d) Class LA_RRR. Instances of subclasses of LA_RRR are Rights, Restrictions or Responsibilities;

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

f) Class LA_SpatialUnit. Instances of this class are spatial units;

Figure 2 shows the basic classes of the LADM. The details of these first four basic classes, and all other LADM classes, are presented in Clause 7. The details of LA_Source and *VersionedObject* are presented in Part 1. The informative Annex C of Part 1 includes an overview how LADM parts are related to each other including Part 2.

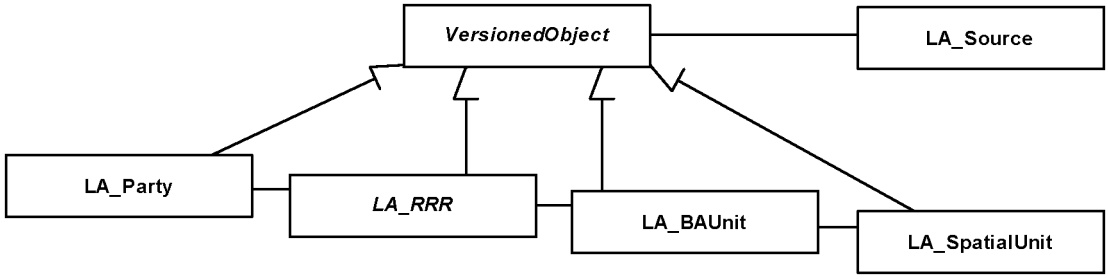


Figure 2 — Basic classes of the core LADM

6.4 Surveying and Representation Subpackage

The sixteen classes of the Surveying and Representation Subpackage are LA_Point, LA_BoundaryFaceString, LA_BoundaryFace, LA_SpatialSource, LA_DesignSource, LA_SurveySource, LA_DistanceObservation, LA_LevelObservation, LA_ImageObservation, LA_AngularObservation, LA_GNSSObservation, LA_TPSObservation, LA_GPRObservation, LA_MBESObservation, LA_PointCloudObservation, and LA_GNSSCorrection, see Figure 3. Except for the first four classes, which are also included in ISO 19152:2012, all classes are introduced in this part of the standard.

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

The LA_SpatialSource class as defined in ISO 19152:2012 LADM, is being updated and extended. There are two subclasses of LA_SpatialSource; LA_SurveySource and LA_DesignSource, to provide more insights at the spatial source registered at the system. A survey is documented with survey sources, instances from class LA_SurveySource. 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 design document (e.g., BIM/IFC, DXF) is documented with design sources, instances from class LA_DesignSource. A spatial source (survey or design) 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.

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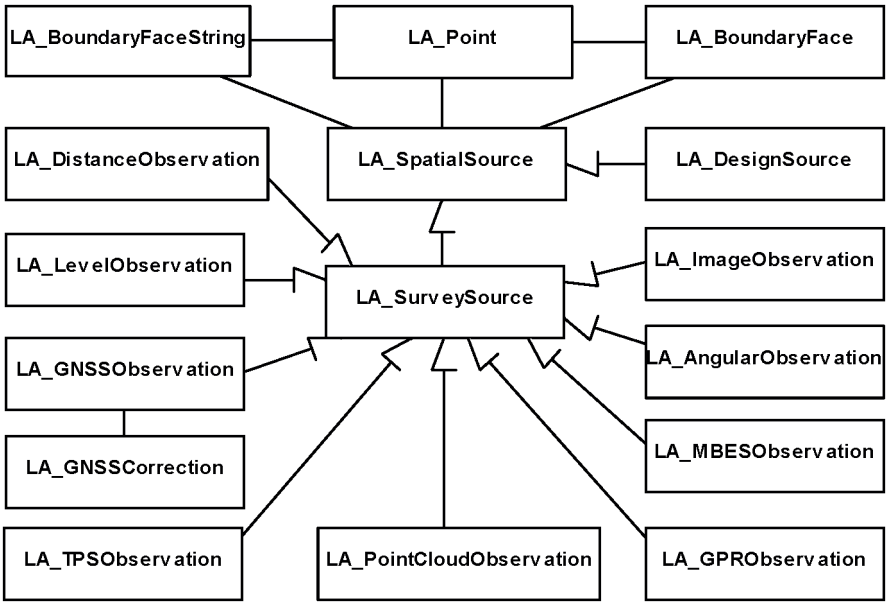


Figure 3 — Classes of the Surveying and Representation Subpackage

The subclasses of the LA_SurveySource relate to the various survey acquisition methods that could be used during a survey, specifically: distance observations, angular observations, level observations, image-based methods, GPS, GNSS and/or using Galileo High Accuracy Services, classic total station, GPR observations, MBES observations and point-clouds observations (LiDAR is a common survey technique for point cloud observation).

The subclasses of LA_SurveySource are extendable based upon sensor characteristics. Specifically in certain countries (countries that follow fixed boundary approach) refined survey model is added to Part 2 to meet the requirements of the cadastral survey community.

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.

7 Content of classes of the LADM and their association

7.1 General

The detailed content of the core LADM packages is given in this part.

7.2 Introduction

All LADM classes adhere to ISO 19103:2015 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 19152-1:2024).

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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, taxation, land cover, building units, utility networks, or archives. See Annex H.

7.3 Special classes

6) **'Authentic Source Documents'**

https://standards.isotc211.org/19152/-2/1/req/authenticsourcedocuments

Requirement 6: Inclusion of new data and data updates shall be documented. This concerns legal administrative data, spatial data and/or technical data.

7.3.1 LA_Source

In the LADM, administrative sources and spatial sources are modelled, starting with a concrete class LA_Source (ISO 19152-1:2024). LA_Source has two subclasses:

a) LA_AdministrativeSource (see 7.5.7);

b) LA_SpatialSource (see 7.7.4).

LA_SpatialSource has two subclasses:

— LA_SurveySource (see 7.7.5);

— LA_DesignSource (see 7.7.6), see Figure 4.

Integrated Source is modelled as an association between the Administrative and the Spatial source classes. Different source types are represented via assignment of multiplicity, where "0" represents a case of a pure Administrative or Spatial source, whereas "1" illustrates a situation where a document contains both attributes from LA_AdministrativeSource as well as from the LA_SpatialSource.

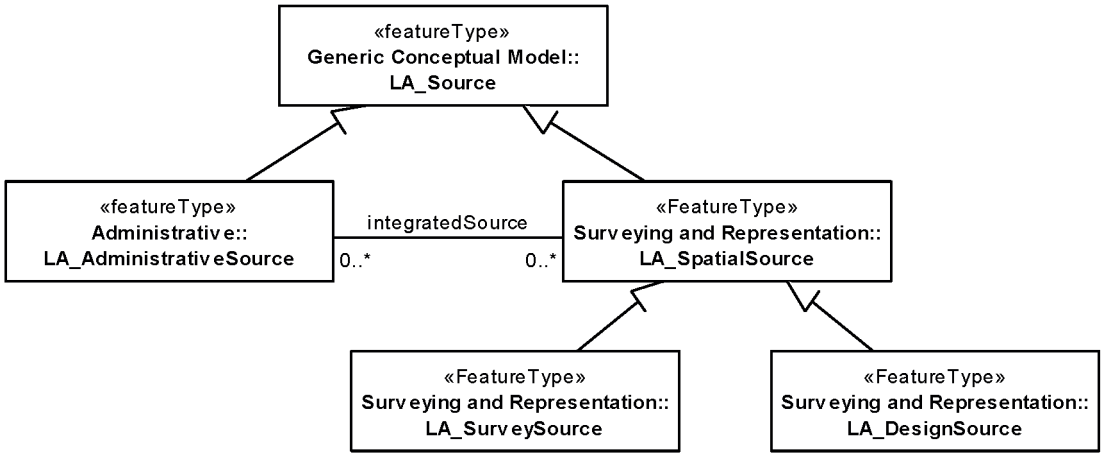


Figure 4 — Class LA_Source (with subclasses)

7) **'Transparency'**

https://standards.isotc211.org/19152/-2/1/req/transparency

Requirement 7: All updates shall be traceable in LADM compliant LASs.

7.3.2 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 timestamp. In this way, database content

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can be reconstructed as it was at any historical moment, in addition all events can be recollected (see Section 6.3.1 of Part 1)

Classes LA_Party, LA_PartyMember, LA_RRR, LA_BAUnit, LA_SpatialUnit, LA_SpatialUnitGroup, LA_RequiredRelationshipSpatialUnit, LA_RequiredRelationshipBAUnit, LA_RequiredRelationshipRRR, LA_Level, LA_SurveyRelation, LA_BoundaryFaceString, LA_BoundaryFace, and LA_Point are all subclasses of class VersionedObject, see Figure 5.

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

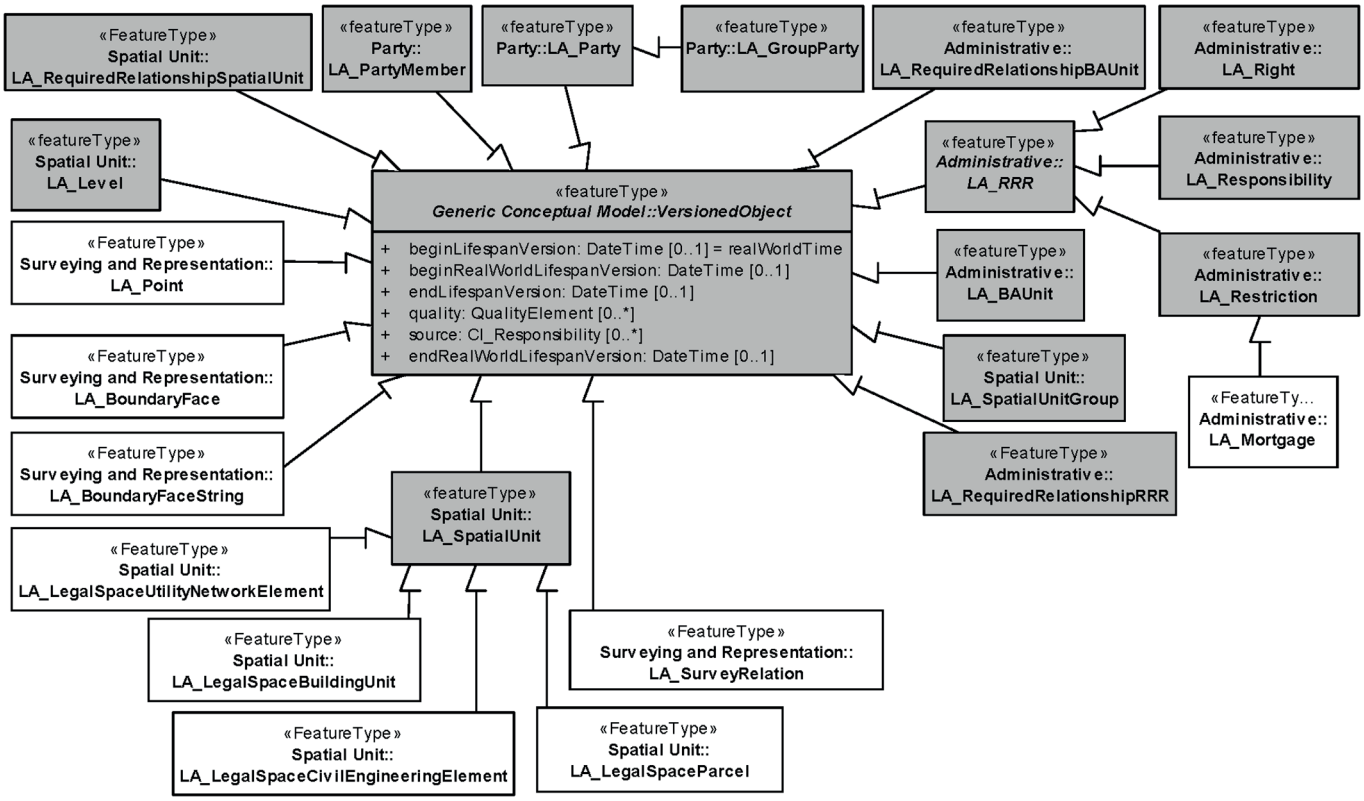


Figure 5 — Classes VersionedObject (with subclasses)

7.4 Classes of Party Package

8) **'Responsible Person'**

https://standards.isotc211.org/19152/-2/1/req/responsibleperson

Requirement 8: The names of persons responsible for transactions shall be part of the source data set (conveyors, surveyors, registrars, etc.). This is one reason for management of history and for documentation of all updates.

9) **'Continuum of Right Parties'**

https://standards.isotc211.org/19152/-2/1/req/continuumofrightparties

Requirement 9: Efficient and effective LAS using this part of ISO 19152 LADM shall support all types of parties. Parties can be persons, or groups of persons, or non-natural persons, that compose an identifiable single entity. A non-natural person may be a tribe, a family, a village, a company, a municipality, the state, a farmer's community/co-operation, a slum dwellers group/organisation, a religious community, and so on. This list may be extended, and it can be adapted to local situations, based on community needs.

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7.4.1 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. A party may be associated to zero or more [0..*] spatial sources, depicting explicit relations between the LA_Party class and the Administrative and/or Spatial classes. Third party that does not necessarily associated with the source documents, is portrayed via role attribute in the LA_Party class itself; see Figure 6.

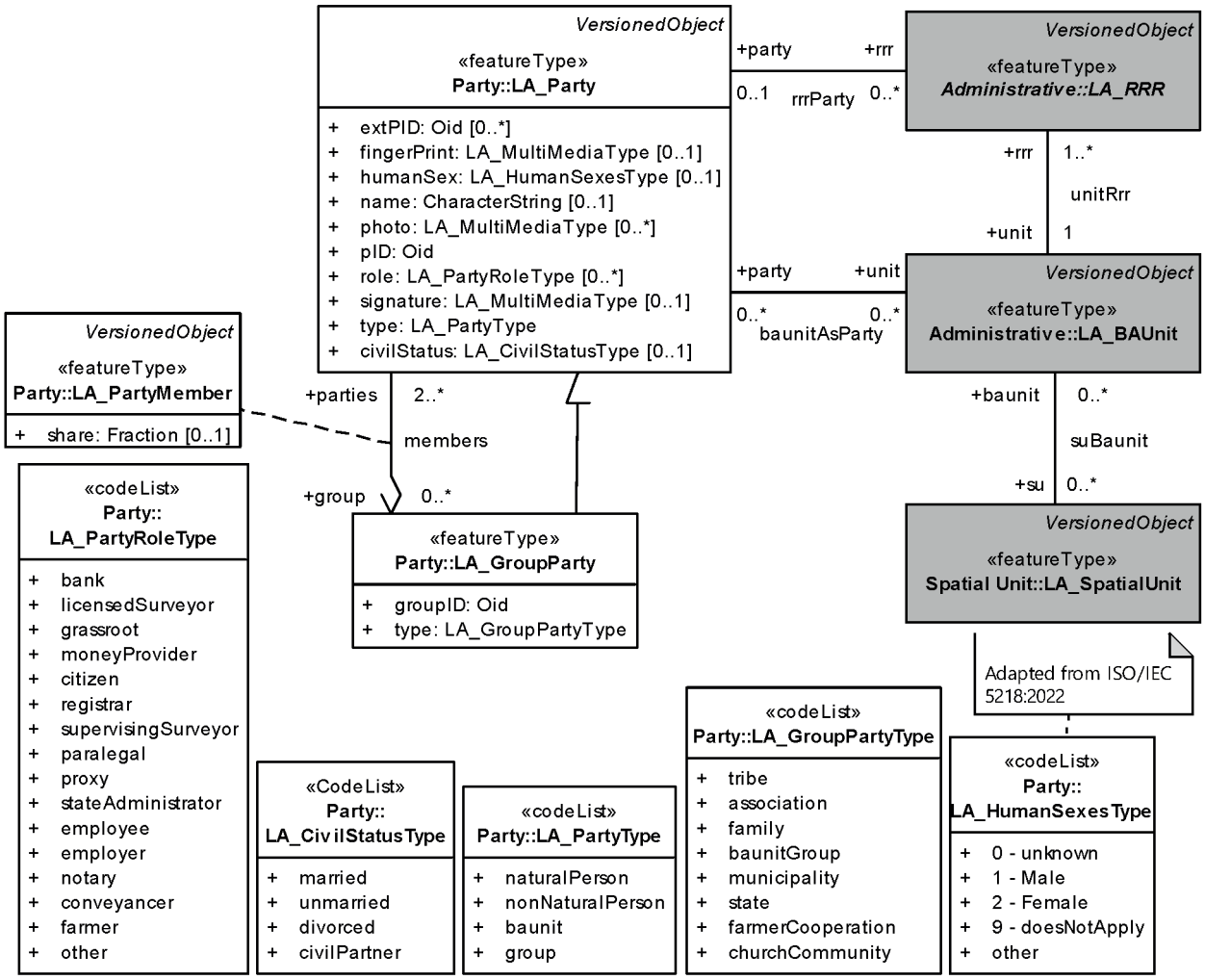


Figure 6 — Content of Party Package and associations to other basic classes

The attributes of LA_Party are shown in Table 5.

Table 5 — Attributes of LA_Party

Attribute name	Type	Cardinality	Description
extPID	Oid	0..*	The identifier of party in an external register
name	CharacterString	0..1	The name of party
pID	Oid	1	The identifier of party
role	LA_PartyRoleType	0..*	The role of party in the data update and maintenance process
type	LA_PartyType	1	The type of party

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Table 5 *(continued)*

Attribute name	Type	Cardinality	Description
photo	LA_MultiMediaType	0..*	The photo of party
fingerprint	LA_MultiMediaType	0..1	The fingerprint of party (natural person only)
signature	LA_MultiMediaType	0..1	The signature of party
humanSex	LA_HumanSexesType	0..1	The human sex type of party (natural person only)
civilStatus	LA_CivilStatusType	0..1	The civil status type of party (natural person only)

NOTE 1 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.

NOTE 2 Party with defined membership is a group party.

NOTE 3 Human sex types are adapted from ISO/IEC 5218:2022. Additional attributes may be added, for example to specify any indicators used in support of the United Nations' Sustainability Goals.

NOTE 4 This part of 19152 is flexible enough to collect statistics about civil status and human sexes in order to support United Nations' Sustainable Development Goal 5 Gender Equality.

EXAMPLE Parties are demonstrated in instance level cases, see Annex D, Figures D.3, D.4 and D.13.

7.4.2 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 6.

The attributes of LA_GroupParty are shown in Table 6.

Table 6 — Attributes of LA_GroupParty

Attribute name	Type	Cardinality	Description
groupID	Oid	1	The identifier of a group party
type	LA_GroupPartyType	1	The type of a group party

LA_GroupParty has a constraint requiring that the sum of the shares of the group party members must be equal to 1. This constraint is only enforced if a class LA_PartyMember exists (see 7.3.2)."

EXAMPLE Group parties are demonstrated in instance level cases, see Annex D, Figures D.3, D.4, D.5 and D.13.

7.4.3 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 6.

The attribute of LA_PartyMember is shown in Table 7.

Table 7 — Attributes of LA_PartyMember

Attribute name	Type	Cardinality	Description
share	Fraction	0..1	The fraction of the whole

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7.5 Classes of Administrative Package

10) **'Basic Administrative Unit'**

https://standards.isotc211.org/19152/-2/1/req/basicadministrativeunit

Requirement 10: In combination to the Triple (1. LA_Party – 2. LA_RRR and/or LA_AdministrativeSource – 3. LA_BAUnit/LA_SpatialUnit) the constellation of basic administrative units shall be supported. The purpose of a BAUnit is the grouping of spatial units, which have the same rights, etc. attached. A BAUnit can play the role of a party: a BAUnit may be owned by one or more other BAUnit.

7.5.1 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 can 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 can 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 7.

The attributes of LA_BAUnit are shown in Table 8.

Table 8 — Attributes of LA_BAUnit

Attribute name	Type	Cardinality	Description
name	CharacterString	0..1	The name of the basic administrative unit
type	LA_BAUnitType	1	The type of the basic administrative unit
uID	Oid	1	The identifier of the basic administrative unit

LA_BAUnit has a constraint requiring that the sum of all the shares for one basic administrative unit must 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 can 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 (share must be specified, unless this is meaningless for the specific type (indicated by shareCheck=false; in this case constraint 'sum (RRR.share) = 1 per type' cannot be applied))."

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 A (group of) BAUnit may be a party.

EXAMPLE Basic administrative units (BAUnit's) are demonstrated in instance level cases, see Annex D, Figures D.1, D.17, D.23, D.24, D.25, D.27, D.28, D.29, D.31, D.32 and D.33.

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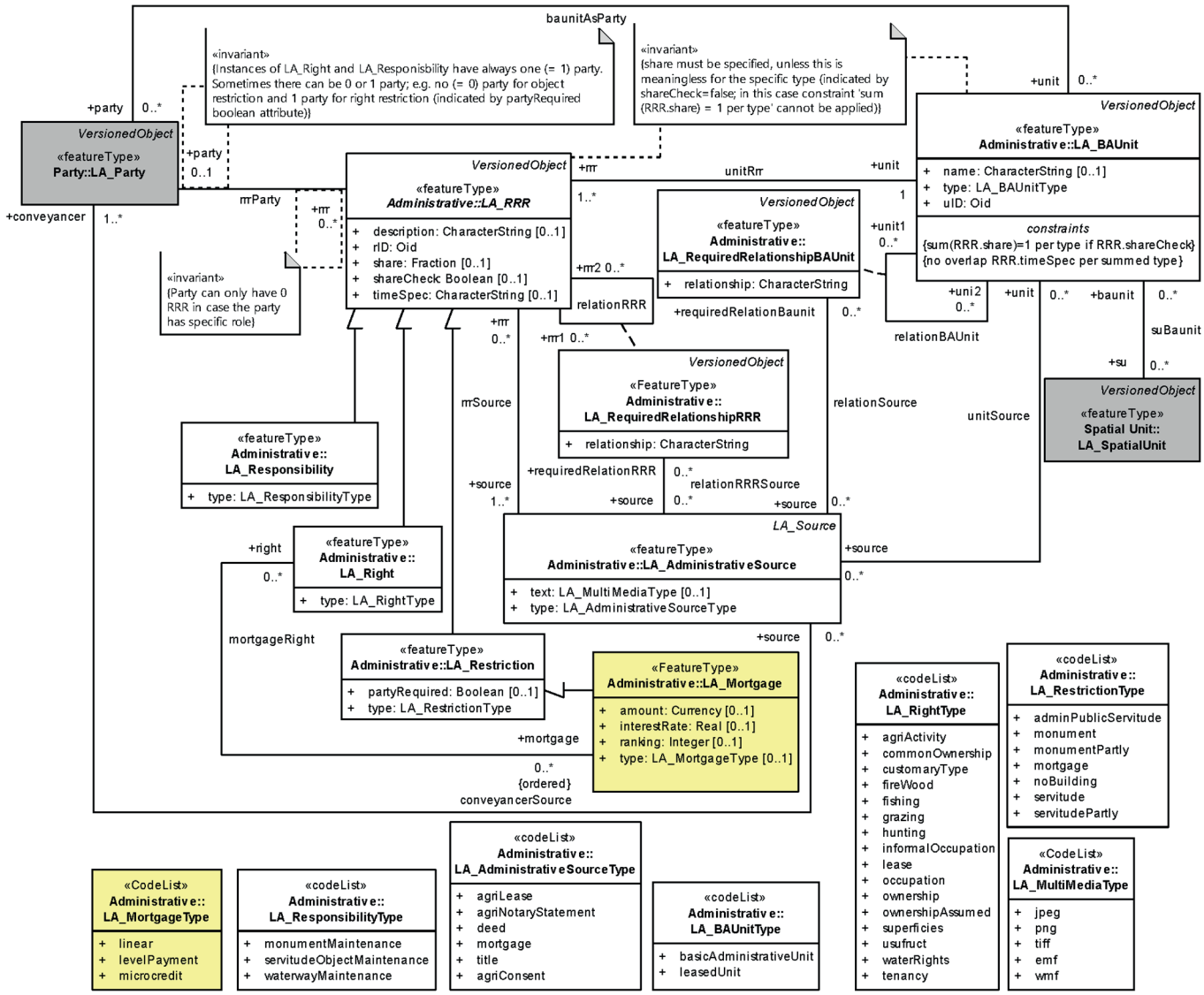


Figure 7 — Content of Administrative Package with associations to other basic classes

11) **'Shares In RRR'**

https://standards.isotc211.org/19152/-2/1/req/sharesinRRR

Requirement 11: Holding shares in rights, restrictions, responsibilities shall be supported.

7.5.2 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 [0..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 can be associated to one or more [1..*] administrative sources (i.e. the right, restriction or responsibility affecting a basic administrative unit can be supported by at least one administrative source); see Figure 7.

The attributes of LA_RRR are shown in Table 9.

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Table 9 — Attributes of LA_RRR

Attribute name	Type	Cardinality	Description
description	CharacterString	0..1	Description regarding the right, restriction or responsibility
rID	Oid	1	The RRR identifier
share	Fraction	0..1	A share in an instance of a subclass of LA_RRR
shareCheck	Boolean	0..1	Indicates whether the constraint in class LA_BAUnit is applicable
timeSpec	CharacterString	0..1	Operational use of a RRR in time sharing

NOTE 1 Attribute timeSpec is capable of handling other temporal descriptions, such as recurring patterns (every weekend, 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 20524-2:2020 and ISO 8601-1:2019).

NOTE 2 Attribute timeSpec can be related to a single time interval with limited duration (e.g., long lease of 25 years), see Annex D, Figures D.1, D.31.

NOTE 3 Additional attributes may be added, for example to specify legal property owner rights, restrictions and responsibilities in a particular jurisdiction.

EXAMPLE There can be parties without an RRR, for example surveyor, and there can also be RRR without parties, especially for public law restrictions.

7.5.3 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 7.

The attribute of LA_Right is shown in Table 10.

Table 10 — Attribute of LA_Right

Attribute name	Type	Cardinality	Description
type	LA_RightType	1	The type of the right

EXAMPLE Rights are demonstrated in instance level cases, see Annex D, Figures D.1, D.8, D.11, D.28 and D.29.

7.5.4 LA_Restriction

An instance of class LA_Restriction is a restriction. LA_Restriction is a subclass of class LA_RRR. LA_Mortgage (8.4.6) is a specialization of LA_Restriction; see Figure 7.

The attributes of LA_Restriction are shown in Table 11.

Table 11 — Attributes of LA_Restriction

Attribute name	Type	Cardinality	Description
partyRequired	Boolean	0..1	Indicates whether a party is required for the registration of the restriction in the association to LA_Party
type	LA_RestrictionType	1	The type of the restriction

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 level cases, see Annex D, Figures D.9, D.16, D.20, D.21 and D.22.

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7.5.5 LA_Responsibility

An instance of class LA_Responsibility is a responsibility. LA_Responsibility is a subclass of class LA_RRR. See Figure 7.

The attribute of LA_Responsibility is shown in Table 12.

Table 12 — Attribute of LA_Responsibility

Attribute name	Type	Cardinality	Description
type	LA_ResponsibilityType	1	The type of the responsibility

EXAMPLE Responsibilities are demonstrated in instance diagrams, see Annex D, Figure D.19.

7.5.6 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 7.

The attributes of LA_Mortgage are shown in Table 13.

Table 13 — Attributes of LA_Mortgage

Attribute name	Type	Cardinality	Description
amount	Currency	0..1	The amount of money of the mortgage
interestRate	Real	0..1	Interest rate of the mortgage (percentage)
ranking	Integer	0..1	The ranking order, if more than one mortgage applies to a right (or rights)
type	LA_MortgageType	0..1	The type of the mortgage

NOTE ISO 4217 may be used for the list of currencies in the ISO 19103:2015 measure.

EXAMPLE Mortgages are demonstrated in instance level cases, see Annex D, Figures D.10, D.11 and D.15.

7.5.7 LA_AdministrativeSource

An instance of class LA_AdministrativeSource is an administrative source. LA_AdministrativeSource is a subclass of class LA_Source. An administrative source can 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 7.

The attributes of LA_AdministrativeSource are shown in Table 14.

Table 14 — Attributes of LA_AdministrativeSource

Attribute name	Type	Cardinality	Description
text	LA_MultiMediaType	0..1	The multimedia of the source document
type	LA_AdministrativeSourceType	1	The type of document

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

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NOTE 2 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.

7.5.8 LA_RequiredRelationshipBAUnit

An instance of association class LA_RequiredRelationshipBAUnit is a required relationship between basic administrative units, see Figure 7. A required relationship between basic administrative units can be associated to zero or more [0..*] administrative sources to provide supporting documentation for the explicit relationship.

The attribute of LA_RequiredRelationshipBAUnit is shown in Table 15.

Table 15 — Attribute of LA_RequiredRelationshipBAUnit

Attribute name	Type	Cardinality	Description
relationship	CharacterString	1	The description of the required relationship

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 BAUnit.

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 may be connected in time when related to the same change, e.g., when a part of a spatial unit is sold.

7.5.9 LA_RequiredRelationshipRRR

An instance of association class LA_RequiredRelationshipRRR is a required relationship between RRRs, see Figure 7. A required relationship between RRRs can be associated to zero or more [0..*] administrative sources to provide supporting documentation for the explicit relationship.

The attribute of LA_RequiredRelationshipRRR is shown in Table 16.

Table 16 — Attribute of LA_RequiredRelationshipRRR

Attribute name	Type	Cardinality	Description
relationship	CharacterString	1	The description of the required relationship

7.6 Classes of Spatial Unit Package

12) **'Continuum of Spatial Units'**

https://standards.isotc211.org/19152/-2/1/req/continuumofspatialunits

Requirement 12: Representation of a broad range of spatial units, with a clear quality indication, shall be supported by an LADM compliant LAS. Spatial units are the areas of land (or water – e.g., water rights and the marine environment) where the rights and social tenure relationships apply. Spatial units can be represented as a text ("from this tree to that river"), as a sketch, as a single point, as a set of unstructured lines, as a surface, or as a 3D volume.

13) **'Spatial Unit Identifiers'**

https://standards.isotc211.org/19152/-2/1/req/spatialunitidentifiers

Requirement 13: Spatial units shall have a unique identifier. A key component in LASs is the spatial unit identifier, the parcel identifier or the unique parcel reference number. This acts as a link between the parcel

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itself and all record related to it. It facilitates data input and data exchange. There can be a need to change identifiers during data collection.

7.6.1 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 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 need to be associated to one or more [1..*] spatial sources (i.e. the spatial unit need to be supported by at least one spatial source). 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 (7.5.3), utility networks (7.5.4), infrastructure (7.5.5) or parcel (7.5.6); see Figure 8. Spatial units can be extended by subtyping in country profiles.

The attributes of LA_SpatialUnit are shown in Table 17.

Table 17 — Attributes of LA_SpatialUnit

Attribute name	Type	Cardinality	Description
area	LA_AreaValue	0..*	The area of the 2D spatial unit
dimension	LA_DimensionType	0..1	The dimension of the spatial unit
extAddressID	Oid	0..*	The link to external address(es) of the spatial unit
label	CharacterString	0..1	Short textual description of the spatial unit
geometry	Geometry	0..1	The geometry of the spatial unit
referencePoint	Point	0..1	The coordinates of a point inside the spatial unit
suID	Oid	1	The spatial unit identifier
surfaceRelation	LA_SurfaceRelationType	0..1	Indicates whether a spatial unit is above or below the surface
volume	LA_VolumeValue	0..*	The volume of the 3D spatial unit

NOTE The method 'createArea( )' constructs geometric primitive of type Collection(Surface) 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 Collection(Solid) 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 level cases, see Annex D, Figures D.6, D.7, D.16, D.17, D.21, D.27 and D.33.

7.6.2 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 8.

The attributes of LA_SpatialUnitGroup are shown in Table 18.

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Table 18 — Attributes of LA_SpatialUnitGroup

Attribute name	Type	Cardinality	Description
hierarchyLevel	Integer	1	The level in the hierarchy of an administrative, or zoning subdivision
label	CharacterString	0..1	Short textual description of the spatial unit group
name	CharacterString	0..1	The name of the spatial unit group
referencePoint	Point	0..1	The coordinates of a point within the spatial unit group
sugID	Oid	1	The identifier of the spatial unit group

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

7.6.3 LA_LegalSpaceBuildingUnit

An instance of class LA_LegalSpaceBuildingUnit is a building unit. LA_LegalSpaceBuildingUnit is a subclass of class LA_SpatialUnit, see Figure 8.

The attributes of LA_LegalSpaceBuildingUnit are shown in Table 19.

Table 19 — Attributes of LA_LegalSpaceBuildingUnit

Attribute name	Type	Cardinality	Description
extPhysicalBuildingUnitID	ExtPhysicalBuildingUnit	0..1	The identifier of the building unit
type	LA_BuildingUnitType	0..1	The type of the building unit

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 level cases, see Annex D, Figures D.6, D.22, D.24, D.27, D.32 and D.33.

7.6.4 LA_LegalSpaceUtilityNetworkElement

An instance of LA_LegalSpaceUtilityNetworkElement is a utility network element. LA_LegalSpaceUtilityNetworkElement is a subclass of class LA_SpatialUnit, see Figure 8.

The attributes of LA_LegalSpaceUtilityNetworkElement are shown in Table 20.

Table 20 — Attributes of LA_LegalSpaceUtilityNetworkElement

Attribute name	Type	Cardinality	Description
extPhysicalUtilityNetworkID	ExtPhysicalUtilityNetwork	0..1	A reference to the physical (technical) description of the utility network element
status	LA_StatusType	0..1	The status of the utility network element
type	LA_UtilityNetworkElementType	0..1	The type of the utility network element

NOTE Networks are implicitly connected. One is only interested in a part of the network, not a network as whole.

EXAMPLE Utility networks are demonstrated in instance level cases, see Annex D, Figure D.15.

7.6.5 LA_LegalSpaceCivilEngineeringElement

An instance of LA_LegalSpaceCivilEngineeringElement is an infrastructure. LA_LegalSpaceCivilEngineeringElement is a subclass of class LA_SpatialUnit, see Figure 8.

The attributes of LA_LegalSpaceCivilEngineeringElement are shown in Table 21.

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Table 21 — Attributes of LA_LegalSpaceCivilEngineeringElement

Attribute name	Type	Cardinality	Description
extPhysicalInfrastructureID	ExtPhysicalInfrastructure	0..1	A reference to the physical (technical) description of civil engineering element
status	LA_StatusType	0..1	The status of civil engineering element
type	LA_CivilEngineeringType	0..1	The type of civil engineering element

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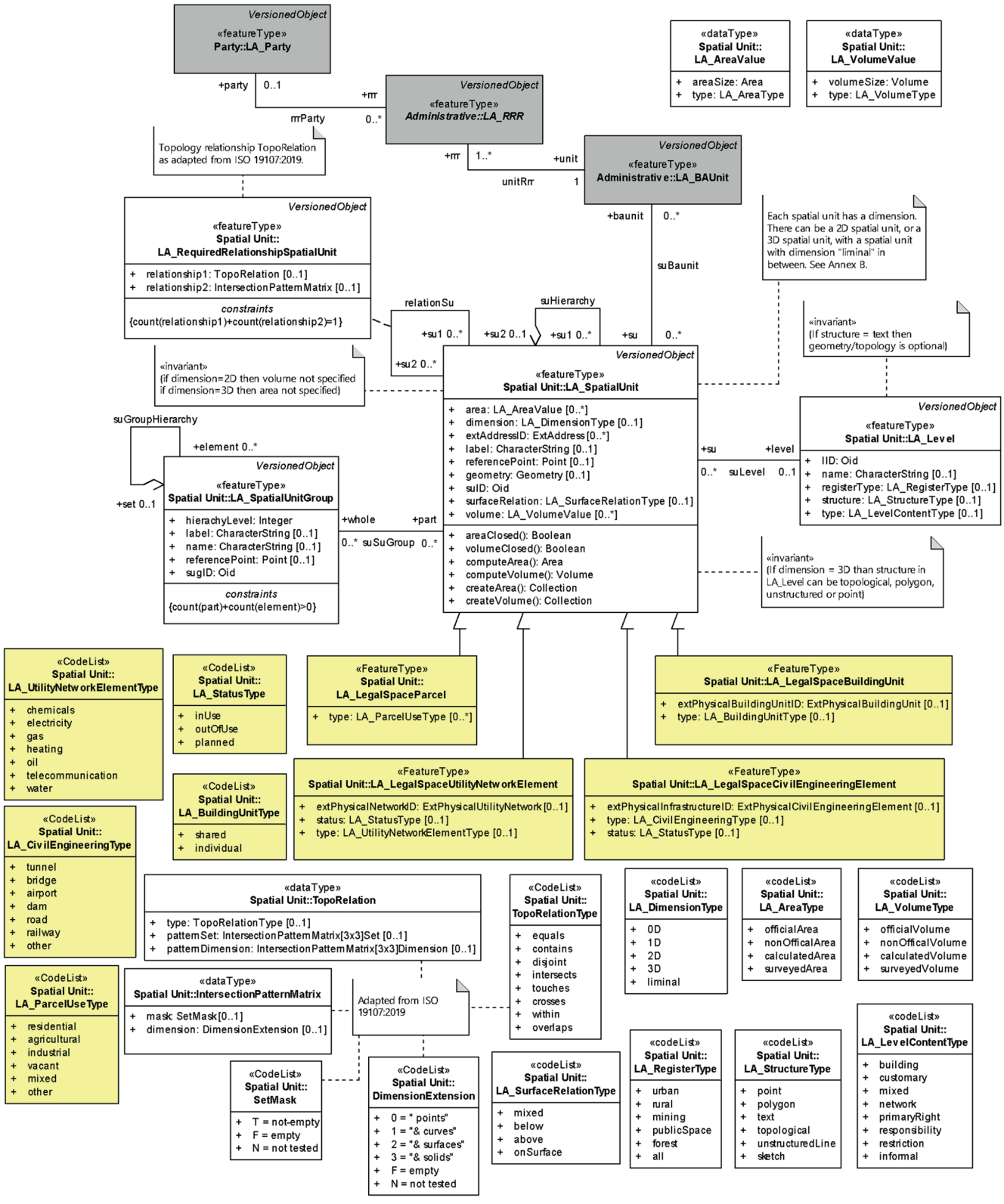


Figure 8 — Content of Spatial Unit Package with associations to other basic classes

7.6.6 LA_LegalSpaceParcel

An instance of LA_LegalSpaceParcel is a parcel. LA_LegalSpaceParcel is a subclass of class LA_SpatialUnit, see Figure 8. The attribute of LA_LegalSpaceParcel Parcel is shown in Table 22.

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Table 22 — Attributes of LA_LegalSpaceParcel

Attribute name	Type	Cardinality	Description
type	LA_ParcelUseType	0..*	The use type of the parcel

7.6.7 LA_Level

An instance of class LA_Level is a level. LA_Level is associated to class LA_SpatialUnit, see Figure 8.

The attributes of LA_Level are shown in Table 23.

Table 23 — Attributes of LA_Level

Attribute name	Type	Cardinality	Description
lID	Oid	1	The identifier of the level
name	CharacterString	0..1	The name of the level
registerType	LA_RegisterType	0..1	The register type of the content of the level
structure	LA_StructureType	0..1	The structure of the level geometry
type	LA_LevelContentType	0..1	The type of the content of the level

EXAMPLE Levels are demonstrated in instance level cases, see Annex D, Figures D.2, D.14, D.16, D.21, D.23, D.24, D.25 and D.32.

7.6.8 LA_RequiredRelationshipSpatialUnit

An instance of association class LA_RequiredRelationshipSpatialUnit is a required relationship between spatial units, see Figures 8.

The attribute of LA_RequiredRelationshipSpatialUnit is shown in Table 24.

Table 24 — Attributes of LA_RequiredRelationshipSpatialUnit

Attribute name	Type	Cardinality	Description
relationship1	TopoRelation	0..1	The description of the required relationship via TopoRelation
relationship2	IntersectionPatternMatrix	0..1	The description of the required relationship via IntersectionPatternMatrix

NOTE The cardinality of TopoRelation or IntersectionPatternMatrix must equal to 1.

7.6.9 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 G).

The attributes of LA_AreaValue are shown in Table 25.

Table 25 — Attributes of LA_AreaValue

Attribute name	Type	Cardinality	Description
areaSize	Area	1	Area of the 2D spatial unit
type	LA_AreaType	1	Indicates the type of area provided

The generic data type LA_VolumeValue is introduced in LADM to provide support for various types of volume values (see Annex G). The attributes of LA_VolumeValue are shown in Table 26.

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Table 26 — Attributes of LA_VolumeValue

Attribute name	Type	Cardinality	Description
volumeSize	Volume	1	Volume of the 3D spatial unit
type	LA_VolumeType	1	Indicates the type of volume provided

The generic data type TopoRelation is introduced in LADM to provide support for topographical relationships (see Annex G). The attributes of TopoRelation are shown in Table 27.

Table 27 — Attributes of TopoRelation

Attribute name	Type	Cardinality	Description
type	TopoRelationType	0..1	The type of topological relationships, see ISO 19107:2019
patternSet	IntersectionPatternMatrix[3x3]Set	0..1	The pattern set matrix, see ISO 19107:2019
patternDimension	IntersectionPatternMatrix[3x3]Dimension	0..1	The pattern dimension of matrix, see ISO 19107:2019

The generic data type IntersectionPatternMatrix is introduced in LADM to provide support for topographical relationships (see Annex G). The attributes of IntersectionPatternMatrix are shown in Table 28.

Table 28 — Attributes of IntersectionPatternMatrix

Attribute name	Type	Cardinality	Description
mask	SetMask	0..1	The set mask of intersection pattern matrix, see ISO 19107:2019
dimension	DimensionExtension	0..1	The dimension extension of intersection pattern matrix, see ISO 19107:2019

7.7 Classes of Surveying and Representation Subpackage

7.7.1 LA_Point

An instance of class LA_Point is a point. A point may be associated to zero or more [0..*] 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 need to be associated to zero or more [0..*] spatial sources, see Figure 9.

The attributes of LA_Point are shown in Table 29.

Table 29 — Attributes of LA_Point

Attribute name	Type	Cardinality	Description
estimatedAccuracy	AbsolutePositionalAccuracy	0..1	The estimated accuracy of the point
interpolationRole	LA_InterpolationType	1	The role of the point in the structure of a straight line or curve
monumentation	LA_MonumentationType	0..1	The type of monumentation
originalLocation	Point	1	The calculated coordinates, based on measurements and observations
pID	Oid	1	The point identifier

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Table 29 *(continued)*

Attribute name	Type	Cardinality	Description
pointType	LA_PointType	1	The type of point
productionMethod	LI_Lineage	0..1	The lineage (19115-1:2014)
transAndResult	LA _Transformation	0..*	Transformation and transformed location

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

7.7.2 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 need to 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 9.

The attributes of LA_BoundaryFaceString are shown in Table 30.

Table 30 — Attributes of LA_BoundaryFaceString

Attribute name	Type	Cardinality	Description
bfsID	Oid	1	The boundary face string identifier
geometry	Curve	0..*	The boundary represented via a curve at ground level
locationByText	CharacterString	0..1	The boundary represented in text

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

EXAMPLE Boundary face strings is demonstrated in instance level case, see Annex D, Figure D.31.

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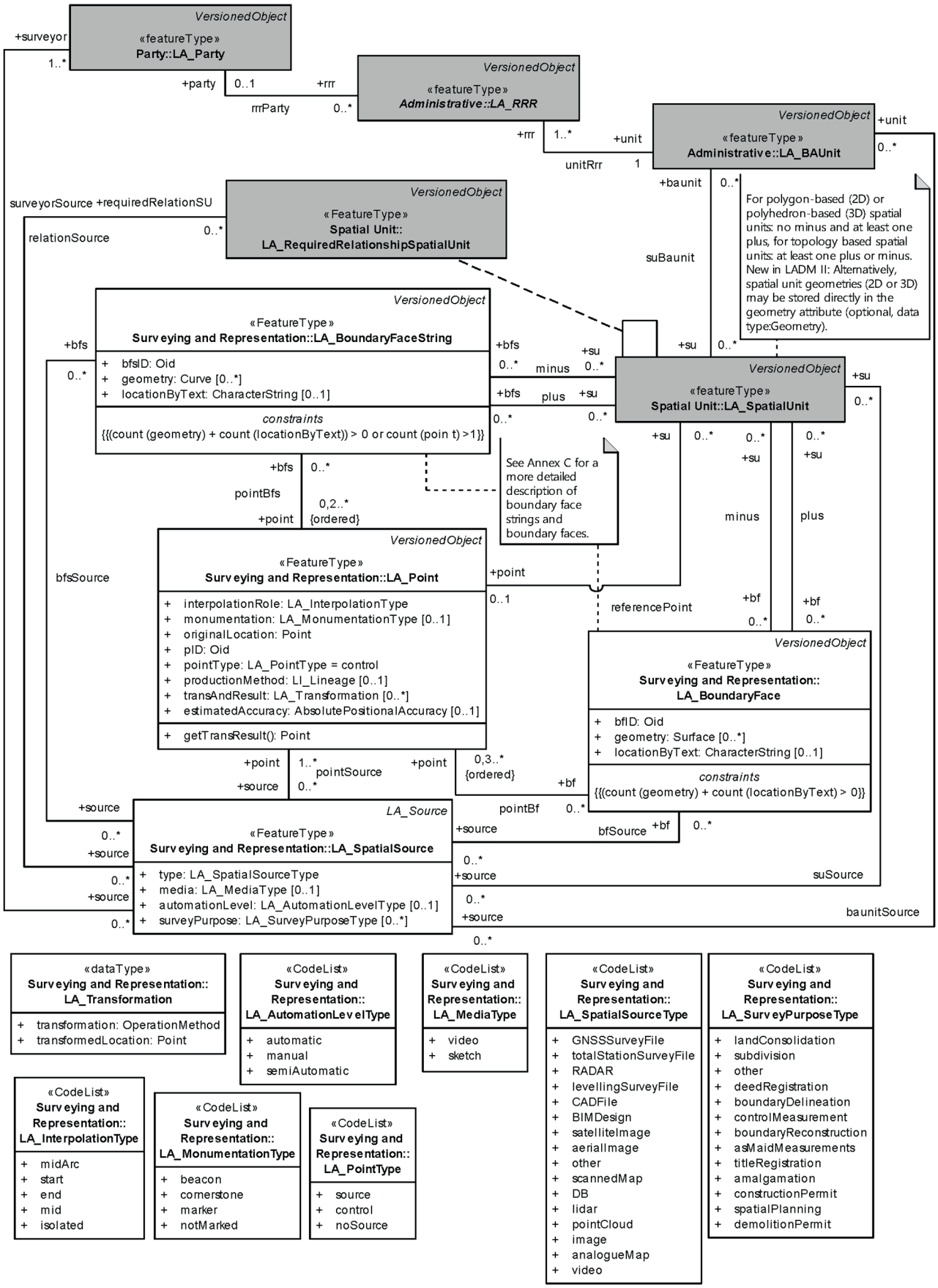


Figure 9 — Basic Classes of the Surveying and Representation Subpackage (1)

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7.7.3 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 need to 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 9.

The attributes of LA_BoundaryFace are shown in Table 31.

Table 31 — Attributes of LA_BoundaryFace

Attribute name	Type	Cardinality	Description
bfID	Oid	1	The boundary face identifier
geometry	Surface	0..*	The boundary represented via a surface in 3D
locationByText	CharacterString	0..1	The boundary represented in text

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

EXAMPLE Boundary faces is demonstrated in instance level case, see Annex D, Figure D.7.

14) **'Spatial Source Based Maps'**

https://standards.isotc211.org/19152/-2/1/req/spatialsourcebasedmaps

Requirement 14: Cadastral maps shall be based on spatial sources, such as surveys, design sources, topographic maps, etc.

7.7.4 LA_SpatialSource

An instance of class LA_SpatialSource is a spatial source. LA_SpatialSource is a subclass of class LA_Source. A spatial source need to 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 face 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 need to 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, need to be specified). See Figures 8.

The optional association class connecting LA_Party and LA_SpatialSource denotes the different roles of a survey executor, see Figure 9.

The attributes of LA_SpatialSource are shown in Table 32.

Table 32 — Attributes of LA_SpatialSource

Attribute name	Type	Cardinality	Description
type	LA_SpatialSourceType	1	The technique of the survey used
media	LA_MediaType	0..1	The source media type
automationLevel	LA_AutomationLevelType	0..1	The process type of automation level
surveyPurpose	LA_SurveyPurposeType	0..*	The purpose of survey

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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.

15) **'Data Acquisition Methods'**

https://standards.isotc211.org/19152/-2/1/req/dataacquisitionmethods

Requirement 15: Surveying of boundaries shall be supported. Surveys may concern the identification of boundaries of spatial units on a photograph, an image, or a topographic map. Surveys can be conventional land surveys, based on hand-held GPS. In all cases the representation of 'legal' reality is differentiated from the 'physical' reality. There may be sketch maps drawn up locally. Depending on the local situation, different registrations or recordings of land rights are possible.

16) **'Cadastral Reference System'**

https://standards.isotc211.org/19152/-2/1/req/cadastralreferencesystem

Requirement 16: Efficient LASs compliant with this part of LADM shall be capable of producing co-ordinates, forming an essential component of cadastral systems. Provisions may be made to accommodate future changes in the reference system that may occur as a result of technical improvements. These may affect all co-ordinate-based systems. Imagery can be used depending on the user requirements, cost, and timing among other factors. It can be possible to include all documentation on data collected as evidence from the field.

17) **'Data Quality'**

https://standards.isotc211.org/19152/-2/1/req/dataquality

Requirement 17: The cadastral information shall be as complete as possible, reliable (which means ready when required), and rapidly accessible. Users of cadastral information need clarity, simplicity and speed in the registration process. Consistency between spatial and legal administrative data is important. Topology integrated with geometry and other attributes is relevant. The system must be ready to keep the information up to date. Data quality of spatial data may be improved in a later stage of development of a LAS, this has to be documented. For combined data products from different sources the quality descriptions and meta data related to the original data are relevant in relation to liability and information assurance.

7.7.5 LA_SurveySource

An instance of class LA_SurveySource is a survey source. A set of measurements such as: distances, bearings, GNNS observations etc. which may be obtained via various survey techniques and stored on designated media. LA_SurveySource is subclass of class LA_SpatialSource. See Figure 10.

The attributes of LA_SurveySource are shown in Table 33.

Table 33 — Attributes of LA_SurveySource

Attribute name	Type	Cardinality	Description
platform	LA_PlatformType	0..1	The platform used for the survey
surveyMethod	LA_SurveyMethodType	0..1	The status of the survey
siteSketchMap	LA_MultiMediaType	0..1	The survey sketch map designed on the site
procedure	OM_Process	0..1	The survey method used (ISO 19156:2023)
accuracyLevel	LA_ObservationsAccuracyType	0..1	The level of observation accuracy expected
equipmentID	ExtEquipment	0..1	The information on equipment used in survey

NOTE The class survey LA_SurveySource and some of its subclasses are adapted/inspired from OGC's LandInfra/InfraGML. There is additional functionality added here to the LandInfra model; for example LA_GNSSCorrection, LA_MBESObservation, LA_GPRObservation and code list values.

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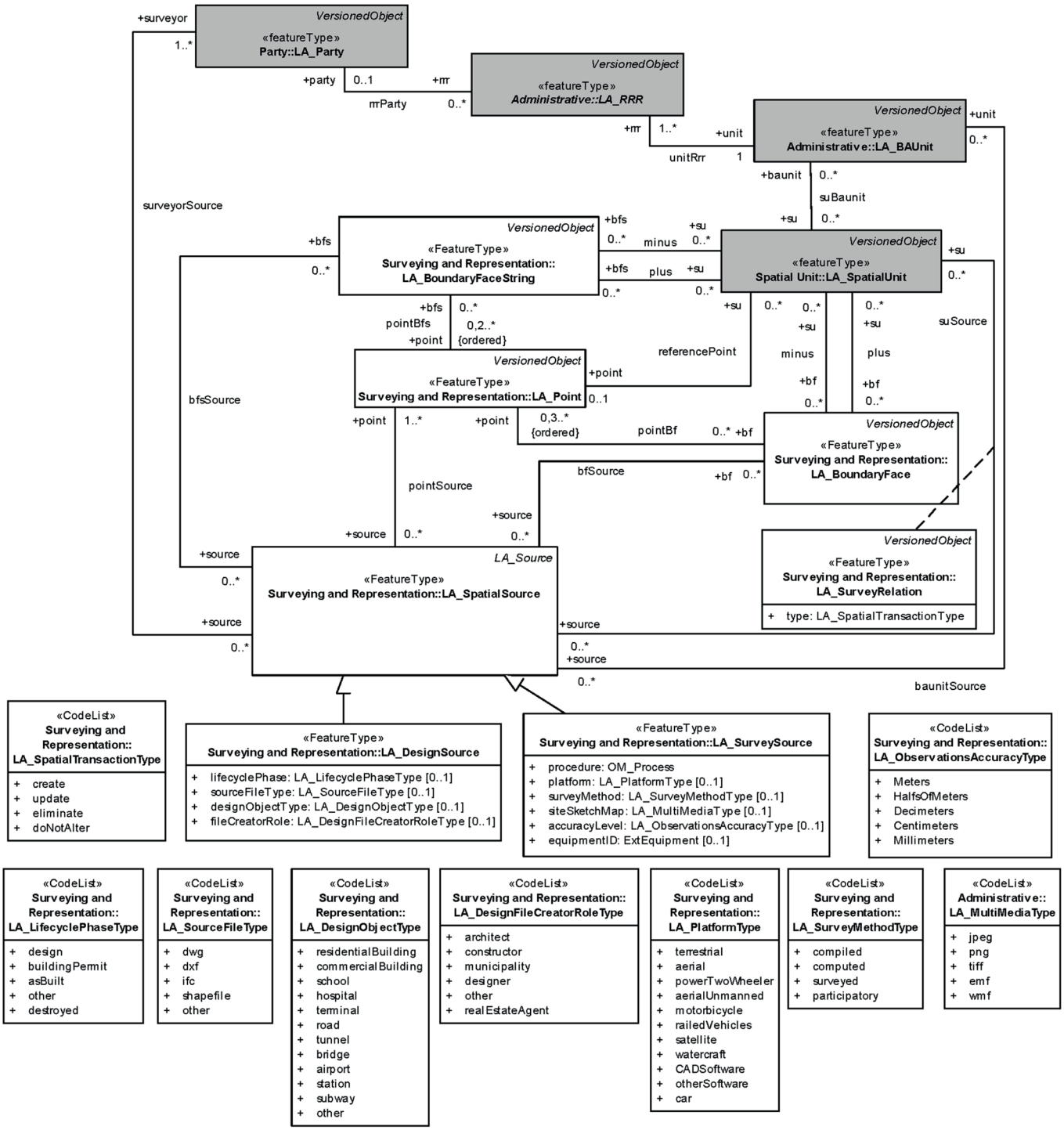


Figure 10 — Basic Classes of the Surveying and Representation Subpackage (2)

7.7.6 LA_DesignSource

An instance of class LA_DesignSource is a source from the design phase of the lifecycle that enables information reuse. LA_DesignSource is subclass of class LA_SpatialSource. See Figure 10.

The attributes of LA_DesignSource are shown in Table 34.

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Table 34 — Attributes of LA_DesignSource

Attribute name	Type	Cardinality	Description
lifecyclePhase	LA_LifecyclePhaseType	0..1	The object's lifecycle phase
sourceFileType	LA_SourceFileType	0..1	The format type of the source file
designObjectType	LA_DesignObjectType	0..1	The type of object/ spatial unit that the design refers to
fileCreatorRole	LA_FileCreatorRoleType	0..1	The role of the design file creator

7.7.7 LA_SurveyRelation

An instance of the association class LA_SurveyRelation is a survey relation. Association class LA_SurveyRelation is an association class between LA_SpatialSource and LA_SpatialUnit, see Figure 10.

The attribute of LA_SurveyRelation is shown in Table 35.

Table 35 — Attributes of LA_SurveyRelation

Attribute name	Type	Cardinality	Description
type	LA_SpatialTransactionType	1	The type of spatial transaction

LADM refers to O&M, but in a very generic form therefore, a refined model for different survey techniques, which addresses survey related aspects is required. Furthermore, in order to explicitly express the purpose of the survey, an association class between the LA_SpatialSource and LA_SpatialUnit is added to the model, see Figure 10.

7.7.8 LA_DistanceObservation

An instance of class LA_DistanceObservation is a survey source obtained by distance observation between the InstrumentPoint and the TargetPoint. LA_DistanceObservation is subclass of class LA_SurveySource. See Figure 11.

The attributes of LA_DistanceObservation are shown in Table 36.

Table 36 — Attributes of LA_DistanceObservation

Attribute name	Type	Cardinality	Description
distance	Real	0..1	The result of the observation
distanceType	LA_DistanceType	0..1	The type of the distance used for the observation
description	CharacterString	0..1	Information about the distance observation

7.7.9 LA_LevelObservation

An instance of class LA_LevelObservation is a survey source obtained by level observation. LA_LevelObservation is subclass of class LA_SurveySource. See Figure 11.

The attributes of LA_LevelObservation are shown in Table 37.

Table 37 — Attributes of LA_LevelObservation

Attribute name	Type	Cardinality	Description
deltaHeight	Real	0..1	The result of the observation
description	CharacterString	0..1	The information about the level observation

7.7.10 LA_AngularObservation

An instance of class LA_AngularObservation is a survey source obtained by angular observation. LA_AngularObservation is subclass of class LA_SurveySource. See Figure 11.

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The attributes of LA_AngularObservation are shown in Table 38.

Table 38 — Attributes of LA_AngularObservation

Attribute name	Type	Cardinality	Description
angle	Real	0..1	The result of the observation
angularType	LA_AngleType	0..1	The type of angle measured during the observation
description	CharacterString	0..1	The information about the angular observation

7.7.11 LA_ImageObservation

An instance of class LA_ImageObservation is a survey source obtained by image-based observation. LA_ImageObservation is subclass of class LA_SurveySource. See Figure 11.

The attributes of LA_ImageObservation are shown in Table 39.

Table 39 — Attributes of LA_ImageObservation

Attribute name	Type	Cardinality	Description
image	Image	0..1	The result of the observation
name	CharacterString	0..1	The name of the image
description	CharacterString	0..1	The information about the image-based observation

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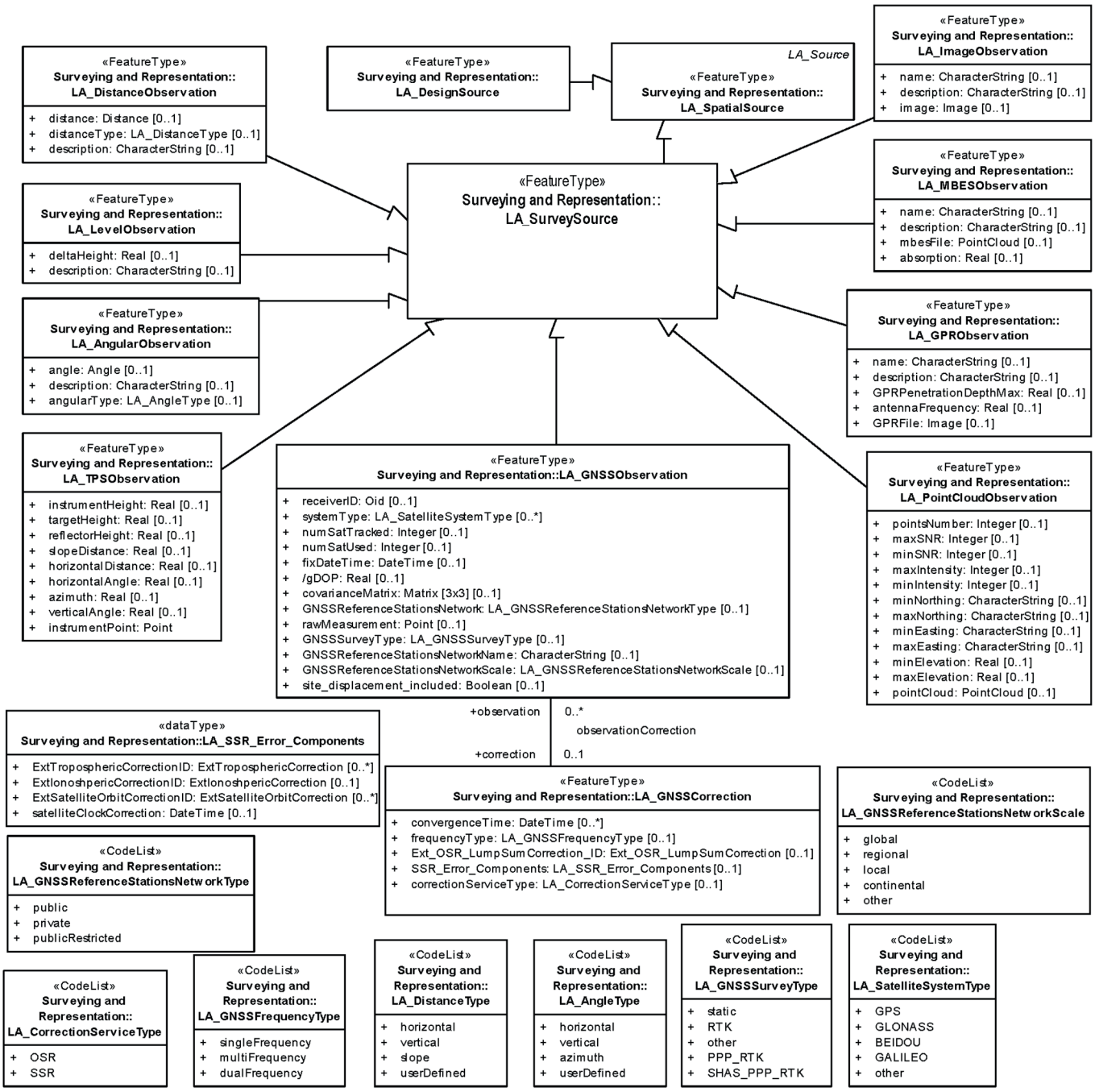


Figure 11 — Basic Classes of the Surveying and Representation Subpackage (3)

7.7.12 LA_TPSObservation

An instance of class LA_TPSObservation is a survey source obtained by using total-station. A TPSObservation contains angular and distance observation from the InstrumentPoint to the TargetPoint. LA_TPSObservation is subclass of class LA_SurveySource. Figure 11.

The attributes of LA_TPSObservation are shown in Table 40.

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Table 40 — Attributes of LA_TPSObservation

Attribute name	Type	Cardinality	Description
instrumentHeight	Real	0..1	The vertical distance between instrument location and InstrumentPoint
targetHeight	Real	0..1	The height of the target
reflectorHeight	Real	0..1	The vertical distance between the reflector and the TargetPoint
slopeDistance	Real	0..1	The slope distance between the InstrumentPoint and the TargetPoint
horizontalDistance	Real	0..1	The horizontal distance between the InstrumentPoint and the TargetPoint
horizontalAngle	Real	0..1	The horizontal angle reading from the InstrumentPoint to the TargetPoint
azimuth	Real	0..1	The azimuth from the InstrumentPoint to the TargetPoint
verticalAngle	Real	0..1	The vertical angle reading from the telescope axis to the reflector
instrumentPoint	Point	0..1	The point used for instrument set-up

7.7.13 LA_PointCloudObservation

An instance of class LA_PointCloudObservation is a survey source obtained by point clouds observation. LA_PointCloudObservation is subclass of class LA_SurveySource. See Figure 11.

The attributes of LA_PointCloudObservation are shown in Table 41.

Table 41 — Attributes of LA_PointCloudObservation

Attribute name	Type	Cardinality	Description
pointsNumber	Integer	0..1	The number of points included in the point cloud observation
maxSNR	Integer	0..1	The maximum value of the quality index of signal to noise ratio
minSNR	Integer	0..1	The minimum value of the quality index of signal to noise ratio
maxIntensity	Integer	0..1	The maximum intensity value in the cloud
minIntensity	Integer	0..1	The minimum intensity value in the cloud
minNorthing	CharacterString	0..1	The minimum Northing
maxNorthing	CharacterString	0..1	The maximum Northing
minEasting	CharacterString	0..1	The minimum Easting
maxEasting	CharacterString	0..1	The maximum Easting
minElevation	Real	0..1	The minimum elevation
maxElevation	Real	0..1	The maximum elevation
poinCloud	PointCloud	0..1	The result of the observation

7.7.14 LA_GNSSObservation

An instance of class LA_GNSSObservation is a survey source obtained by using GNSS receivers. A LA_GNSSObservation contains all the data related to the GNSS observation. It is subclass of class LA_SurveySource. See Figure 11.

The attributes of LA_GNSSObservation are shown in Table 42.

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Table 42 — Attributes of LA_GNSSObservation

Attribute name	Type	Cardinality	Description
receiverID	Oid	0..1	The unique identifier of the receiver used for the observation
systemType	LA_SatelliteSystem-Type	0..*	The type of satellite system that was used for the position calculation
numSatTracked	Integer	0..1	The number of satellites that has been tracked from the rover position
numSatUsed	Integer	0..1	The number of satellites that has been used for the position calculation
/gDOP	Real	0..1	The Geometric Dilution of Precision (GDOP), derived value from the Matrix
covarianceMatrix	Matrix [3x3]	0..1	The covariance matrix of the observation
fixDateTime	DateTime	0..1	The date and time of GPS signal
GNSSSurveyType	LA_GNSSSurvey-Type	0..1	The type of GNSS techniques used
GNSSReferenceStationsNet-work	LA_GNSSRefer-enceStationsNet-workType	0..1	The type of reference stations used
GNSSReferenceStationsNet-workName	CharacterString	0..1	The name of reference stations' network used
GNSSReferenceStationsNet-workScale	LA_GNSSRefer-enceStationsNet-workScale	0..1	The scale of reference stations' network used
site_displacement_included	Boolean	0..1	if the site displacement to be applied to a SSR position (e.g., Earth tides) is already included
rawMeasurement	Point	0..1	The raw result of the observation

7.7.15 LA_GNSSCorrection

An instance of class LA_GNSSCorrection is a survey source obtained by implementing the corrections to correct the GNSS observations. A LA_GNSSCorrection contains all the data related to the corrections of GNSS observation. It is subclass of class LA_GNSSObservation. See Figure 11.

The attributes of LA_GNSSCorrection are shown in Table 43.

Table 43 — Attributes of LA_GNSSCorrection

Attribute name	Type	Cardinality	Description
correctionServiceType	LA_CorrectionService-Type	0..1	The category of the corrections' concept used
convergenceTime	DateTime	0..*	The convergence time of GNSS observation
frequencyType	LA_GNSSFrequency-Type	0..1	The frequency range of GNSS correction
Ext_OSR_LumpSumCor-rection_ID	Ext_OSR_LumpSumCor-rection	0..1	The lump sum of corrections of OSR
SSR_Error_Components	LA_SSR_Error_Compo-nents	0..1	The components of corrections of SSR

7.7.16 LA_GPRObservation

An instance of class LA_GPRObservation is a survey source obtained by GPR observation.

The attributes of LA_GPRObservation are shown in Table 44.

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Table 44 — Attributes of LA_GPRObservation

Attribute name	Type	Cardinality	Description
name	CharacterString	0..1	The name of GPR observation
description	CharacterString	0..1	The information about the GPR observation
GPRPenetrationDepthMax	Real	0..1	The maximum depth penetration of GPR observation
antennaFrequency	Real	0..1	The antenna frequency of GPR observation
GPRFile	Image	0..1	The result file of the observation

7.7.17 LA_MBESObservation

An instance of class LA_MBESObservation is a survey source obtained by MBES observation.

The attributes of LA_MBESObservation are shown in Table 45.

Table 45 — Attributes of LA_MBESObservation

Attribute name	Type	Cardinality	Description
name	CharacterString	0..1	The name of GPR observation
description	CharacterString	0..1	The information about the MBES observation
MBESFile	PointCloud	0..1	The result file of the observation
absorption	Real	0..1	The absorption amount of the observation

7.7.18 Data types for Surveying and Representation Subpackage

The Surveying and Representation Subpackage has two data type: LA_Transformation and LA_SSR_Error_Components. The generic data type LA_Transformation is introduced in LADM to provide support for transformations of coordinates between two reference systems, while the generic data type LA_SSR_Error_Components to provide all the information regarding State Space Representation corrections.

The attributes of LA_Transformation are shown in Table 46.

Table 46 — Attributes of LA_Transformation

Attribute name	Type	Cardinality	Description
transformation	OperationMethod	1	The description of transformation method used to associated location value (ISO 19111:2019)
transformedLocation	Point	1	The location obtained from the transformation operation method

The attributes of LA_SSR_Error_Components are shown in Table 47.

Table 47 — Attributes of LA_SSR_Error_Components

Attribute name	Type	Cardinality	Description
satelliteClockCorrection	DateTime	0..1	The clock correction of the satellite used
ExtTroposphericCorrectionID	ExtTroposphericCorrection	0..*	The parameters of the tropospheric correction
ExtSatelliteOrbitCorrectionID	ExtSatelliteOrbitCorrection	0..*	The parameters of the orbit correction (3D)
ExtIonoshpericCorrectionID	ExtIonoshpericCorrection	0..1	The parameters of the ionospheric correction

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7.8 Associations between classes

In this clause, three tables summarize all the relationships between the LADM classes:

a) for associations between classes, see Table 48;

b) for generalizations between classes, see Table 49;

c) for aggregations between classes, see Table 50.

The information in these tables is included to assist the readability of the standard and are based on the models.

Table 48 — Associations between the LADM classes

Class 1[a]	Class 2[a]	Association name	Role name End 1	Multiplicity	Role name End 2	Multiplicity
AdministrativeSource	BAUnit	-	source	0..*	unit	0..*
AdministrativeSource	Party	conveyancer-Source	source	0..*	conveyancer	1..*
AdministrativeSource	RRR	-	source	1..*	rrr	0..*
AdministrativeSource	RequiredRelation-ship-BAUnit	relationSource	source	0..*	requiredRela-tionBAUnit	0..*
AdministrativeSource	SpatialSource	integrated-Source	-	0..*	-	0..*
BAUnit	BAUnit	relationBAUnit	unit1	0..*	unit2	0..*
BAUnit	RRR	-	baunit	1	rrr	1..*
BoundaryFace	SpatialSource	-	-	0..*	source	0..*
BoundaryFace	SpatialUnit	minus, plus	-	0..*	-	0..*
BoundaryFaceString	Point	-	-	0..*	-	0,2..*
BoundaryFaceString	SpatialSource	-	-	0..*	source	0..*
GNSSObservation	GNSSCorrection	observation-Correction	observation	0..*	connection	0..1
Mortgage	Right	-	-	0..*	-	0..*
Party	BAUnit	baunitAsParty	-	0..1	-	0..1
Point	BoundaryFace	-	point	0,3..*	-	0..*
Point	BoundaryFaceString	-	-	0,2..*	-	0..*
RRR	Party	-	rrr	0..*	party	0..1
RRR	RequiredRelation-ship-RRR	relationRRR	rrr1	0..*	rrr2	0..*
Source	Party	-	-	0..*	represented by	
SpatialSource	BAUnit	-	-	0..*	-	0..*
SpatialSource	Party	conveyancer-Source	source	0..*	surveyor	1..*
SpatialSource	RequiredRelation-ship-SpatialUnit	source		0..*		0..*
SpatialSource	Point	-	source	0..*	sourcePoint	1..*
SpatialUnit	BAUnit	-	-	0..*	-	0..*
SpatialUnit	Level	-	su	0..*	level	0..1
SpatialUnit	Point	referencePoint	-	0..1	-	0..1
SpatialUnit	SpatialSource	-	-	0..*	-	0..*
SpatialUnit	SpatialUnit	-	element	0..*	set	0..1
SpatialUnit	SpatialUnitGroup	-	part	0..*	whole	0..*

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

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Table 49 — Generalizations between the LADM classes

Superclass[a]	Subclass[a]
Restriction	Mortgage
RRR	Right
RRR	Restriction
RRR	Responsibility
Party	GroupParty
Source	AdministrativeSource
Source	SpatialSource
VersionedObject	*RRR*
VersionedObject	BAUnit
VersionedObject	RequiredRelationshipBAUnit
VersionedObject	RequiredRelationshipSpatialUnit
VersionedObject	RequiredRelationshiRRR
VersionedObject	SpatialUnit
VersionedObject	SpatialUnitGroup
VersionedObject	Level
VersionedObject	BoundaryFace
VersionedObject	BoundaryFaceString
VersionedObject	Point
VersionedObject	Party
VersionedObject	PartyMember
SpatialSource	DesignSource
SpatialSource	SurveySource
SurveySource	DistanceObservation
SurveySource	LevelObservation
SurveySource	TPSObservation
SurveySource	PointCloudObservation
SurveySource	AngularObservation
SurveySource	ImageObservation
SurveySource	GNSSObservation
SurveySource	GNSSCorrection
SurveySource	GPRObservation
SurveySource	MBESObservation
SpatialUnit	LegalSpaceBuildingUnit
SpatialUnit	LegalSpaceUtilityNetworkElement
SpatialUnit	LegalSpaceCivilEngineeringElement
SpatialUnit	LegalSpaceParcel

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

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