BS EN ISO 19152-2:2025



BSI Standards Publication

Geographic information — Land Administration Domain Model (LADM)

Land registration

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National foreword

This British Standard is the UK implementation of EN ISO 19152-2:2025. It is identical to ISO 19152-2:2025. Together with BS EN ISO 19152-3:2024 and BS EN ISO 19152-1:2024, it supersedes BS EN ISO 19152:2012 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee IST/36, Geographic information.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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European foreword

This document (EN ISO 19152-2:2025) has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" in collaboration with Technical Committee CEN/TC 287 “Geographic Information” the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2025, and conflicting national standards shall be withdrawn at the latest by December 2025.

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The text of ISO 19152-2:2025 has been approved by CEN as EN ISO 19152-2:2025 without any modification.

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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 document 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).

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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 all other parts of the ISO 19152 series, cancels and replaces the first edition (ISO 19152:2012), which has been technically revised.

The main changes are as follows:

— This document defines 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 other ISO/TC 211 documents (i.e. definitions, data types) have been reflected, and corresponding adjustments have been made where necessary.

— Requirements to which a land registration system can conform have been formulated.

— This document introduces 13 new (featureType) classes (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), which are different from ISO 19152:2012. These new classes also include specific attributes. In addition, the attributes of the 3 new (featureType) classes of ISO 19152-1 (LA_RequiredRelationshipRRR, LA_LegalSpaceCivilEngineeringElement, LA_LegalSpaceParcel) have been introduced into this document. No (featureType) classes originally specified in ISO 19152:2012 have been removed.

— The surveying and representation sub-packages have been refined with types of observation information, such as distance, level, angular, image, terrestrial positioning system (TPS), point cloud, global navigation satellite system (GNSS) and ground-penetrating radar (GPR).

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— In order to support all types of spatial units, two new subclasses for LA_SpatialUnit have been introduced: 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 and introduced, based on the definition given in ISO 19107. In addition, 3 code lists (i.e. TopoRelationType, DimensionExtension and SetMask) have been introduced based on the definition given in ISO 19107.

— The optional attributes human sex, signature, fingerprint, photo and civil status have been added to LA_Party.

— One multiplicity of an association has been changed so that a point can now be associated with more than one spatial unit.

— The former Annex I has been refined and repositioned as Annex B (normative).

— The former Annex A has been redesigned in accordance with the requirements of the main body of this document.

— A new Annex K and Annex L have been introduced

— The former Annex H and Annex N have been deleted.

— All the other annexes not mentioned have been updated and refined, including notably:

  — Annex C, which has been refined and extended to support all types of spatial unit representation; and

  — Annex G, which 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).

— 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 document 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 (LA) that concerns parties and the 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 (i.e. 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);[52]

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

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

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 this document with a more refined survey model.

Until now, most countries (or states, provinces) have developed their own land administration system (LAS). Some systems are centralized, and others decentralized. 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 LASs do not facilitate meaningful communication across borders. However, looking from a distance, it can be observed that the different systems are in principle largely the same: they are all based on the relationships between people and land, linked by (ownership or use) rights, and are in most countries influenced by developments in information and communication technology (ICT). Furthermore, the two main functions of every land administration (including cadastre and/or land registry) are:

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

2) providing information from the (national) registers.

Land administration is the process of recording and distributing information about the relationship between people and land (this concerns ownership, value and the use of land and its associated resources). Every LAS includes some form of land registration, which is a process for recording, and in some countries guaranteeing, information about the ownership of 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 recognized as a legally valid one. These recognized rights are in principle eligible for registration, with the purpose being to assign a certain legal meaning to the registered right (e.g. a title). Therefore, land administration systems are not just "handling geographic information", as they represent a lawfully meaningful relationship amongst people, and between people and land.

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LA activity deals with huge amounts of data, which are of a dynamic nature, and requires a continuous maintenance process. The role of ICT is therefore 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, building information models and geographical information systems), as well as a growing demand for new services and 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. In addition, it forms the basis for meaningful communication between different systems.

Standardization has become a well-known process in the work of LA 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, etc. Computerized systems require further standardization when topology and the identification of single boundaries are introduced. In existing LASs and land registries, standardization is generally limited to the region, or jurisdiction, where the LA (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.

Conformance in relation to this document is laid out in Clause 4, and a conformance test is specified in Annex A. Clause 5 provides 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 the refined survey model. A comprehensive set of informative examples (using instance level cases) is available in Annex D.

This document provides 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 provided in the INSPIRE cadastral parcels discussed 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 covered in Annex I. Annex J explains the link between this document and 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 buildings.

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Geographic information — Land Administration Domain Model (LADM) —

Part 2: Land registration

1 Scope

This document:

— defines a reference land administration domain model (LADM) covering basic information-related components of land registration (including elements above and below the surface of the Earth);

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

  — parties (people and organizations);

  — basic administrative units, rights, responsibilities and restrictions (RRRs);

  — 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);

— provides terminology for land administration (LA), based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions;

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

— provides a basis for national and regional profiles; and

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

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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 (operational decision) of the responsible party.

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 areas, 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.

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 line strings 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 with the face via the boundary relations. These can be organized as rings.

[SOURCE: ISO 19107:2019, 3.38]

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3.1.6
level
<LADM> set of spatial units with either a single geometric, topologic coherence, or thematic coherence or a combination of these coherences

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.

EXAMPLE 5 A spatial unit can have no topology at a certain moment in time and the same spatial unit can have topology at a later moment in time. This indicates the same spatial unit with a different representation in two levels.

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: Points can be used to define one or more boundary faces or boundary face strings.

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

Note 4 to entry: A single point can represent a spatial unit.

[SOURCE: ISO 19136-1:2020, 3.1.47, modified — Notes 2, 3 and 4 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 can 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 Abbreviated terms

BAUnit	basic administrative unit
CRS	Coordinate Reference System
CSV	comma-separated values
DBMS	data base management system
F&G	Framework and Guidelines
FIG	International Federation of Surveyors
GDOP	geometric dilution of precision
GLII	Global Land Indicator Initiative
GNSS	global navigation satellite system
GPR	ground-penetrating radar
GPS	Global Positioning System
HTML	Hypertext Markup Language
ICT	information and communication technology
INSPIRE	Infrastructure for Spatial Information in the European Community
LA	land administration
LADM	land administration domain model
LAS	land administration system
LGAF	Land Governance Assessment Framework
lidar	light detection and ranging
MBES	multibeam echosounder
MDA	model driven architecture
MLGT	Multi-Lingual Glossary of Terms (ISO/TC 211)
OGC	Open Geospatial Consortium
OWL	Web Ontology Language
RDF	Resource Description Framework
RRR	right, restriction, responsibility
SDG	Sustainable Development Goal
SDI	spatial data infrastructure
SKOS	Simple Knowledge Organization System
SSR	state space representation

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STDM	Social Tenure Domain Model
TPS	terrestrial positioning system
VGGTs	Voluntary Guidelines on the Responsible Governance on Tenure of Land, Fisheries and Forests
UML	Unified Modeling Language
XML	Extensible Markup Language

4 Conformance

4.1 Conformance requirements and testing

Conformance to this document (ISO 19152-2 – Land registration) consists of alignment with the requirements established in 4.2 and Clauses 6 and 7. The methodology described in the abstract test suite given in Annex A (following ISO 19105) shall be used for testing conformance to these requirements.

The name and contact information of the maintenance agency for this document can be found at www.iso.org/maintenance_agencies.

4.2 Conformance classes

1) BasedOnGenericConceptualModel

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

Requirement 1: This document is based on ISO 19152-1 – Generic conceptual model. All requirements contained in ISO 19152-1 shall apply to this document.

2) ContinuumOfRights

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

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

3) GroupingPeopleLand

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

Requirement 3: Groupings of people and land shall be supported. The flexibility of the 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) DifferentOrganizations

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

Requirement 4: LA data can be maintained by different organizations, and within one organization at many sites. Administrative territories for organizations 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) KeepDataToSource

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

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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 organizations. Multi-source information products require avoidance of redundancy and good standardization protocols.

5 Notation

The conceptual schema specified in this document is described using the Unified Modeling Language (UML), following the guidance of ISO 19103.

Several model elements used in this schema are defined in other ISO geographic information standards. By convention with some ISO/TC 211 International Standards (e.g. ISO 19115-1, ISO 19156), names of UML classes, with the exception of basic data type classes, include a two-letter prefix that identifies the document and the UML package in which the class is defined. This provides a global unique name for the class. UML classes defined in this document have the two-letter prefix of LA. Table 1 lists the prefixes as defined for some of the other parts of the ISO 19152 series. The same prefix is used for ISO 19152-1 and this document (ISO 19152-2) to support backward compatibility. Table 2 lists the prefixes used by LADM.

Table 1 — Sources of internally defined UML classes

Prefix	Document	Part
LA	ISO 19152-1	Generic conceptual model
LA	ISO 19152-2	Land registration
MG	ISO 19152-3	Marine georegulation
VM	ISO 19152-4[a]	Valuation information
SP	ISO 19152-5[b]	Spatial plan information

[a] Under preparation. Stage at the time of publication: ISO/FDIS 19152-4:2025.

[b] Under preparation. Stage at the time of publication: ISO/FDIS 19152-5:2025.

Table 2 — External sources used by LADM

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

6 Overview of the LADM conceptual information model

6.1 General

LA in most countries is the product of multiple agencies/authorities working together to create an ecosystem. LADM is a reflection of how this ecosystem can be formally modelled.

Documents addressing land administration and geo-regulation make use of the generic general feature model as described in ISO 19109. ISO 19109 describes a feature-oriented approach where a feature may have thematic, temporal, spatial, quality, etc. attributes. The spatial geometries derive directly from this structure.

When registering informal rights, the Social Tenure Domain Model (STDM) shall be used, as specified in Annex B. STDM is a specialization of LADM.

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6.2 Packages and sub-packages of the LADM

The LADM is organized into a set of packages and sub-packages (see Figure 1); see ISO 19152-1:2024,5.2. ISO 19152-1 gives the generic structure and this document (ISO 19152-2) details the attributes, associations and their multiplicities. ISO 19152-1 and ISO 19152-2 together form an application schema. Figure 1 shows all classes of ISO 19152-1 and ISO 19152-2.

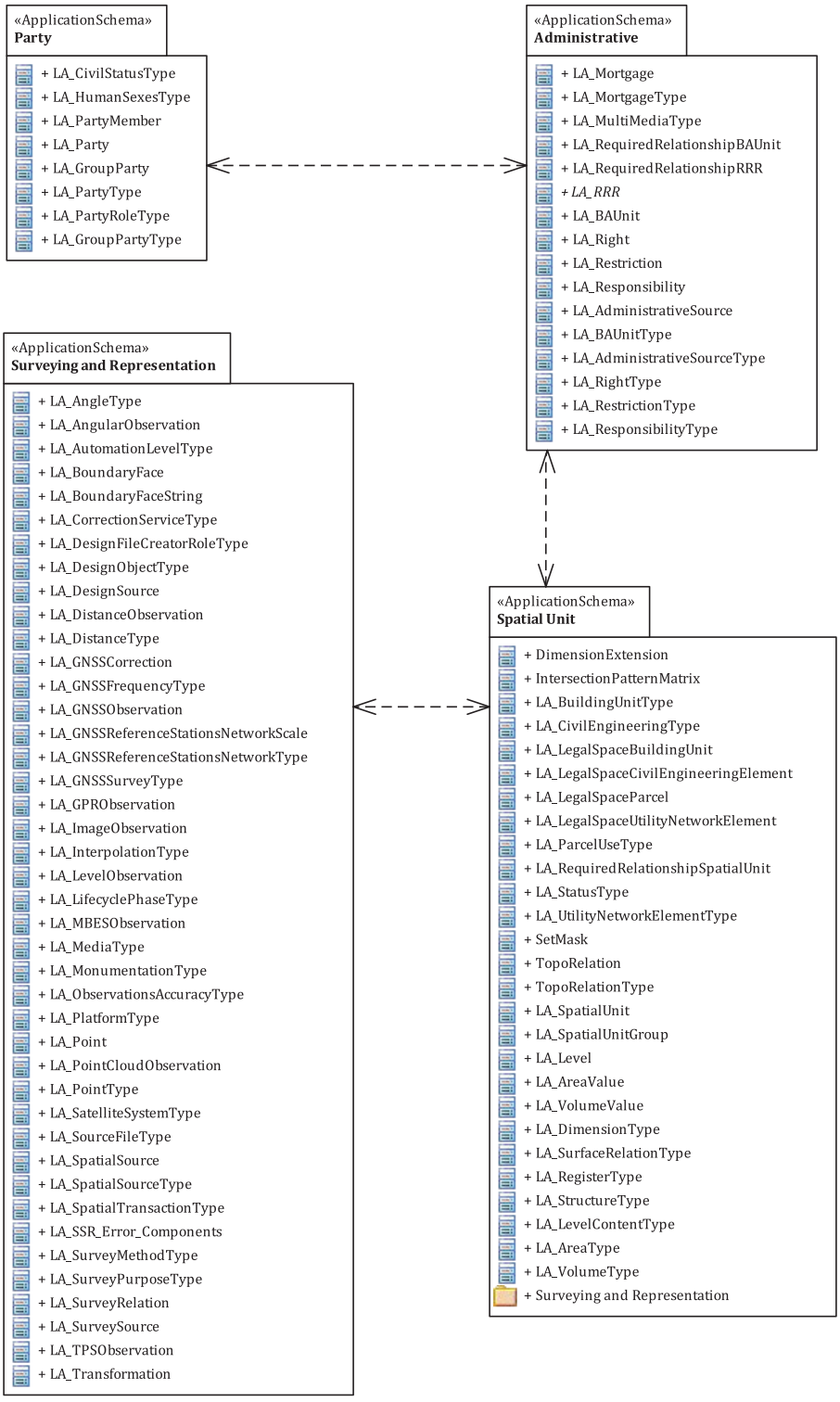


Figure 1 — Packages of the core LADM (with their respective classes)

Table 3 shows which packages and classes are defined in which part of the ISO 19152 series.

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Table 4 shows which packages and code lists are defined in which part of the ISO 19152 series.

No attributes are available in ISO 19152-1, except for the special classes. This document (ISO 19152-2) gives detailed descriptions about the classes introduced in ISO 19152-1 and the classes introduced in this document.

Table 3 — Packages and classes of ISO 19152-1 and ISO 19152-2

(Sub)Package name	Class name	Defined part
Special classes	LA_Source, VersionedObject, Oid, Fraction	ISO 19152-1
	—	ISO 19152-2
Party	LA_Party, LA_GroupParty, LA_PartyMember	ISO 19152-1
	—	ISO 19152-2
Administrative	LA_BAUnit, LA_RRR, LA_Right, LA_Restriction, LA_Responsibility, LA_AdministrativeSource, LA_RequiredRelationshipBAUnit, LA_RequiredRelationshipRRR	ISO 19152-1
	LA_Mortgage	ISO 19152-2
Spatial unit	LA_SpatialUnit, LA_SpatialUnitGroup, LA_Level, LA_RequiredRelationshipSpatialUnit	ISO 19152-1
	LA_LegalSpaceParcel, LA_LegalSpaceBuildingUnit, LA_LegalSpaceUtilityNetworkElement, LA_LegalSpaceCivilEngineeringElement, LA_AreaValue, LA_VolumeValue	ISO 19152-2
Surveying and representation	—	ISO 19152-1
	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	ISO 19152-2

Table 4 — Packages and code lists of ISO 19152-1 and ISO 19152-2

(Sub)Package name	Code list name	Defined part
Special classes	LA_AvailabilityStatusType	ISO 19152-1
	—	ISO 19152-2
Party	—	ISO 19152-1
	LA_PartyType, LA_PartyRoleType, LA_HumanSexesType, LA_CivilStatusType, LA_GroupPartyType	ISO 19152-2
Administrative	—	ISO 19152-1
	LA_BAUnitType, LA_AdministrativeSourceType, LA_RightType, LA_RestrictionType, LA_ResponsibilityType, LA_MortgageType, LA_MultiMediaType	ISO 19152-2

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Table 4 *(continued)*

(Sub)Package name	Code list name	Defined part
Spatial unit	—	ISO 19152-1
	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	ISO 19152-2
Surveying and representation	—	ISO 19152-1
	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	ISO 19152-2

6.3 Basic classes of the LADM

The core LADM is based on six basic classes:

1) Class LA_Source: Instances of this class are sources;

2) Class VersionedObject: Instances of subclasses of VersionedObject are all LADM classes except for LA_Source;

3) Class LA_Party: Instances of this class are parties;

4) Class LA_RRR: Instances of subclasses of LA_RRR are rights, restrictions or responsibilities;

5) Class LA_BAUnit: Instances of this class are basic administrative units;

6) 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 ISO 19152-1.

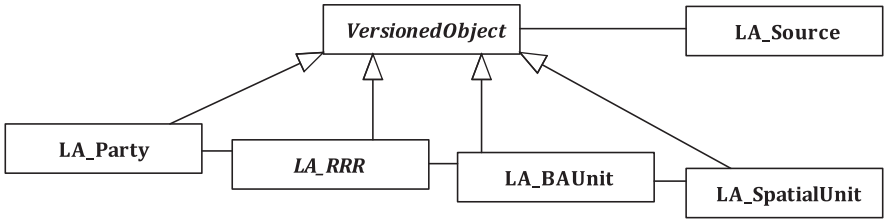


Figure 2 — Basic classes of the core LADM

6.4 Surveying and representation sub-package

The sixteen classes of the surveying and representation sub-package 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 LA_Point, LA_BoundaryFaceString, LA_BoundaryFace and

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LA_SpatialSource classes, which are also included in ISO 19152:2012, all classes of the surveying and representation sub-package are introduced in this document.

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) can potentially 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, is updated and extended. There are two subclasses of LA_SpatialSource, LA_SurveySource and LA_DesignSource, which provide more insights at the spatial source registered at the system. A survey is documented with survey sources, which are 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. building information model) is documented with design sources, which are 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.

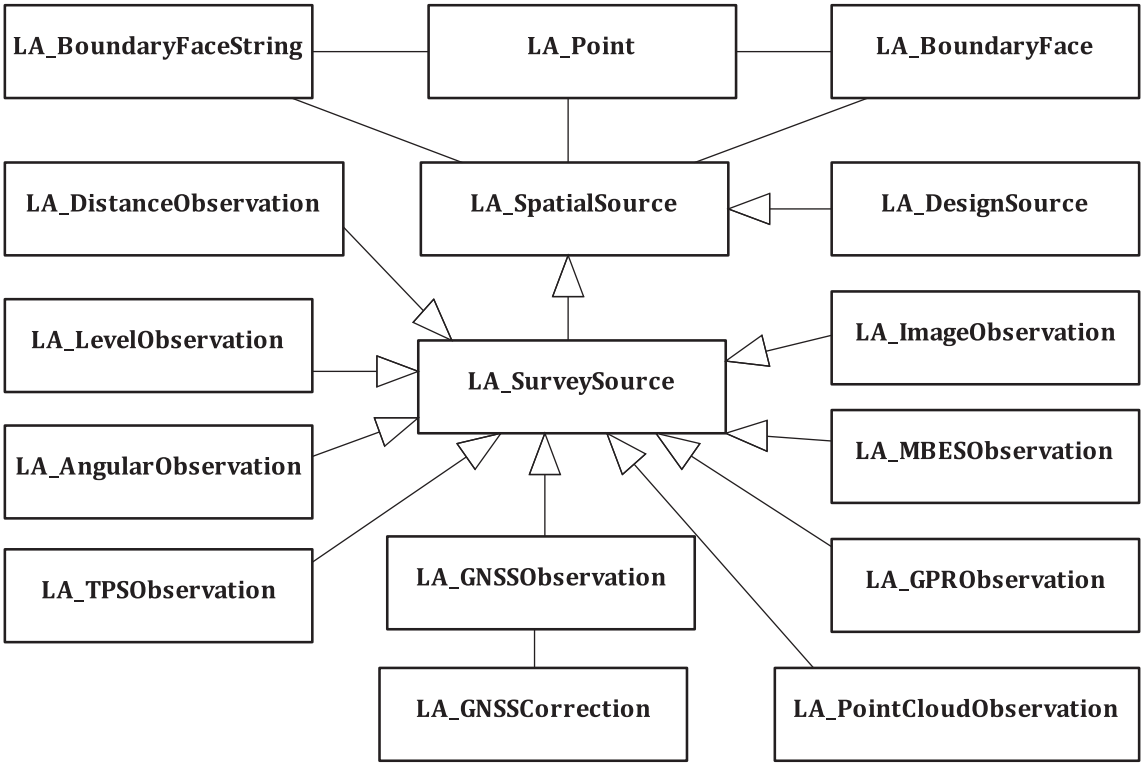


Figure 3 — Classes of the surveying and representation sub-package

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, ground-penetrating radar (GPR) observations, multibeam echosounder (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. The surveying and representation sub-package is extended to this document (ISO 19152-2) to meet the needs of the cadastral survey community; see Figure 3.

The individual points are instances of class LA_Point, which is associated to LA_SpatialSource. While the complete spatial unit is not required to be represented, a spatial source may be associated to several points.

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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.

Annex C explains the 2D and 3D representations of spatial units, spatial unit profiles and the refined survey model.

7 Content of classes of the LADM and their association

7.1 General

The detailed content of the core LADM packages is given in Clause 7.

All LADM classes adhere to the ISO 19103 stereotype class featureType (a feature type is a class of features, i.e. abstractions of real-world phenomena, having common properties). Many LADM classes are subclasses of class VersionedObject (see ISO 19152-1).

7.2 Special classes

7.2.1 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 7.4.7);

b) LA_SpatialSource (see 7.6.4).

LA_SpatialSource has two subclasses:

— LA_SurveySource (see 7.6.5);

— LA_DesignSource (see 7.6.6), 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.

6) AuthenticSourceDocuments

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) Transparency

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

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

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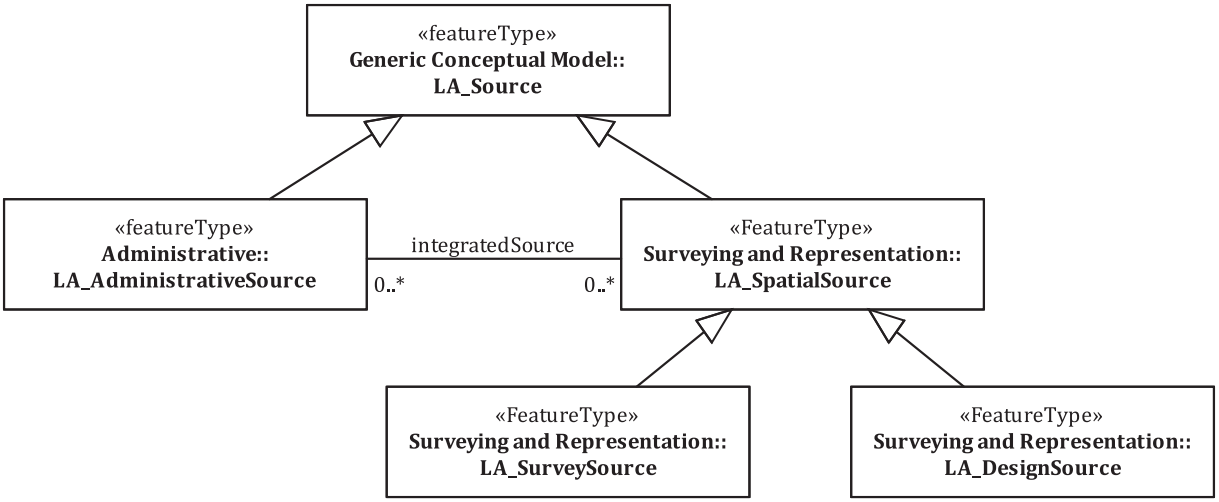


Figure 4 — Class LA_Source (with subclasses)

7.2.2 VersionedObject

Class VersionedObject is introduced in the LADM to manage and maintain historical data in the database. History requires inserted and superseded data to be given a timestamp. In this way, database content can be reconstructed as it was at any historical moment. In addition, all events can be recollected (see ISO 19152-1:2024, 6.3.1.)

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.

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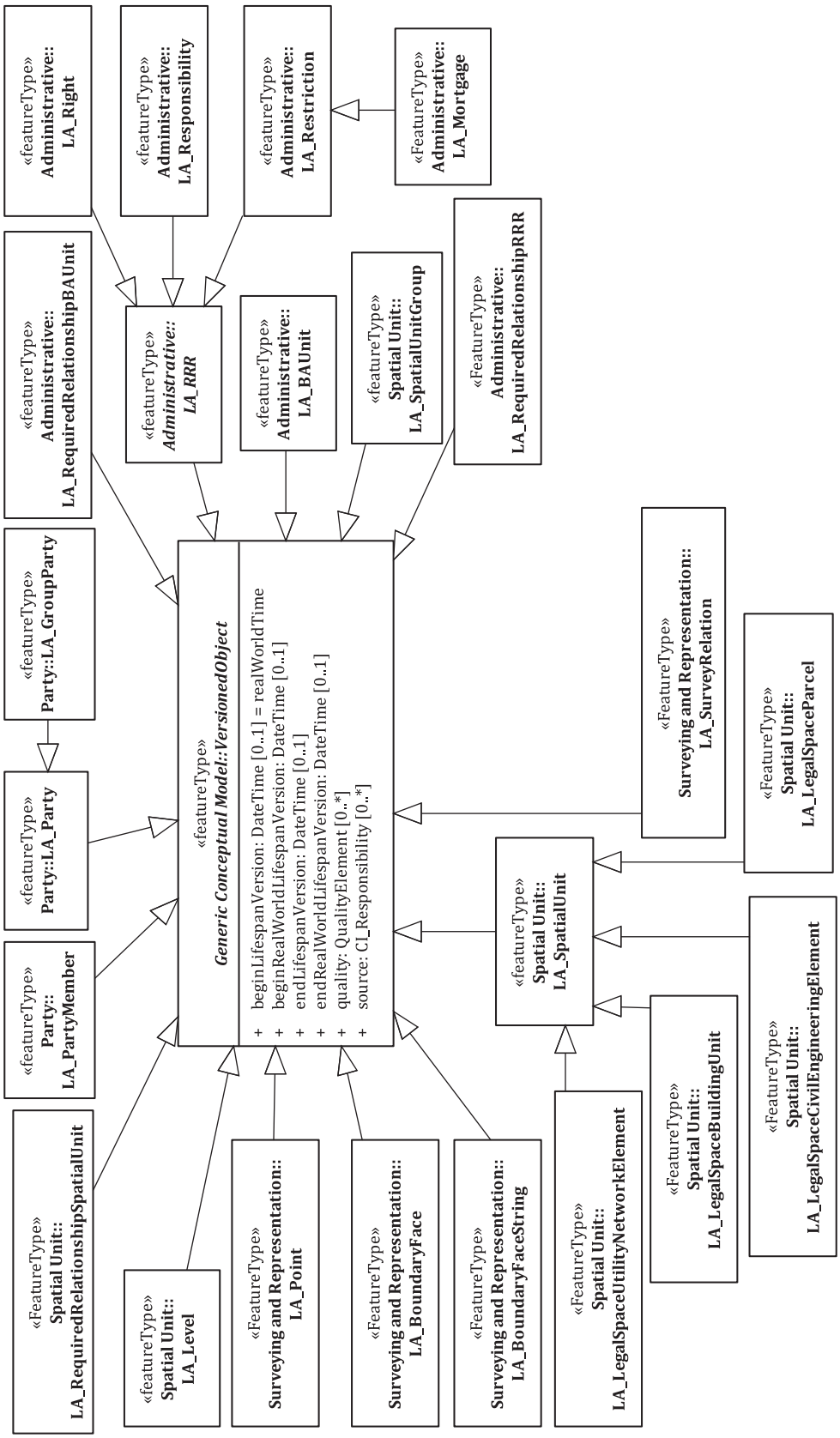


Figure 5 — Classes VersionedObject (with subclasses)

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7.3 Classes of Party Package

7.3.1 LA_Party

An instance of class LA_Party is a party. A party is associated to zero or more [0..*] instances of a subclass of LA_RRR. LA_Party is also associated to LA_BAUnit, to cater for the fact that a basic administrative unit can be a party (e.g. a basic administrative unit holding an easement on another basic administrative unit). A party may be associated to zero or more [0..*] administrative sources. 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; see Figure 6. The example code list values of the party package are shown in Figure 7.

8) ResponsiblePerson

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) ContinuumOfRightParties

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

Requirement 9: Efficient and effective LASs using this document 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 farmers' community/co-operation, an informal settlement resident's group/organization, a religious community, basic administration unit, etc. This list may be extended, and it can be adapted to local situations, based on community needs.

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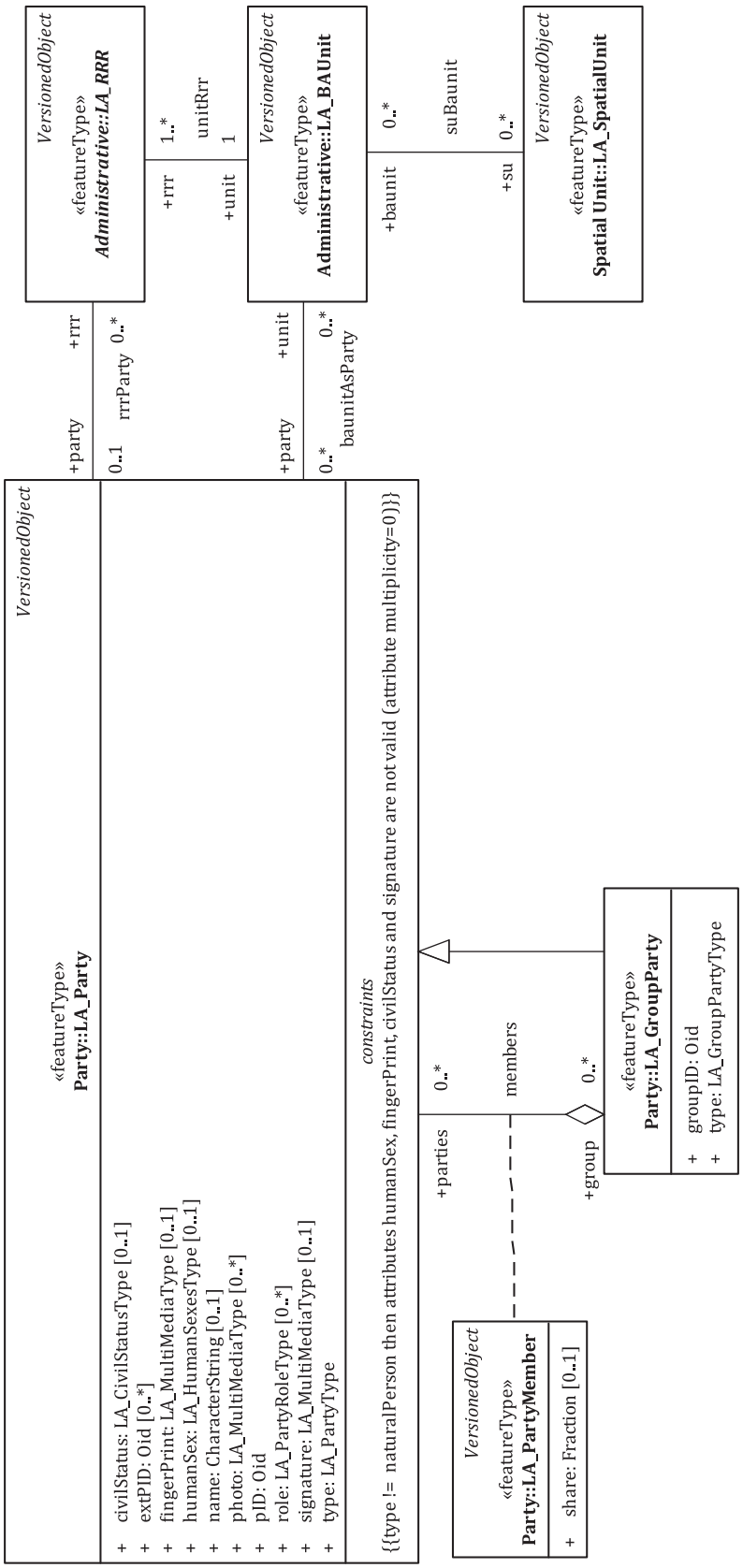


Figure 6 — Content of party package and associations to other basic classes

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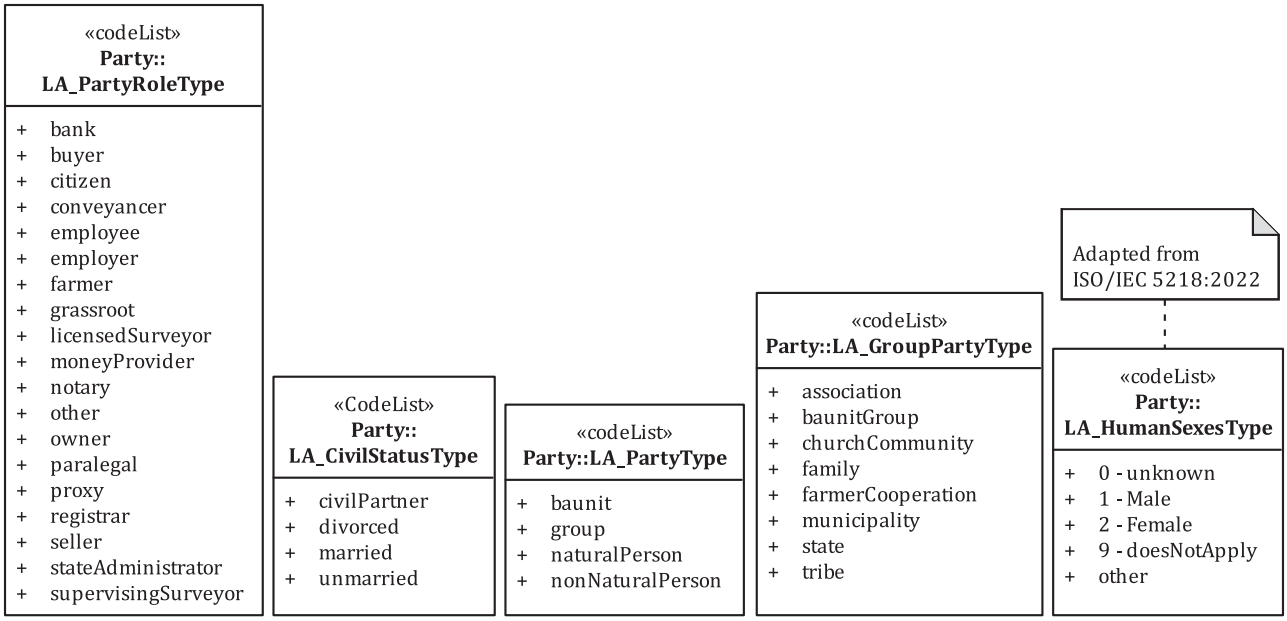


Figure 7 — Code lists of party package

The attributes of LA_Party are shown in Table 5.

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, for example, this conveyancer is not involved in any subclass of LA_RRR.

NOTE 2 Party with defined membership is a group party. Alternatively, members can be non-defined.

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

NOTE 4 This document is sufficiently flexible to collect statistics about civil status and human sexes in order to support United Nations' Sustainable Development Goal (SDG) 5, Gender equality.

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

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
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	Signature of party (natural person only)
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)

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7.3.2 LA_GroupParty

An instance of class LA_GroupParty is a group party. Class LA_GroupParty is a subclass of LA_Party, thus allowing instances of class LA_GroupParty to have an association with instances of class LA_RRR (and thereby also to class LA_BAUnit). A group party consists of zero or more [0..*] parties, but also of other group parties (i.e. 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.

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

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

7.3.3 LA_PartyMember

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

7.4 Classes of Administrative Package

7.4.1 LA_BAUnit

An instance of class LA_BAUnit is a basic administrative unit. LA_BAUnit is associated to class LA_Party (a party may be a basic administrative unit). A basic administrative unit is associated to zero or more [0..*] spatial units. A basic administrative unit can be associated to one or more [1..*] instances of RRR (i.e. a basic administrative unit cannot exist if there is not at least one RRR 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 RRR 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 8. The example code list values of the administrative package are shown in Figure 9.

10) BasicAdministrativeUnit

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

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purpose of a BAUnit is the grouping of spatial units that 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 BAUnits.

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 the sum of all the shares for one basic administrative unit to equal 1 for the same subclass of class LA_RRR, unless "share" is meaningless with regard to the type of RRR. The constraint can be applied only to instances valid at the same moment in time (life span).

LA_BAUnit has a constraint requiring no overlap to be allowed between timeSpecs for the same RRR type and the same basic administrative unit. Share is required to 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 space).

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(s) can be a party.

EXAMPLE Basic administrative units (BAUnits) 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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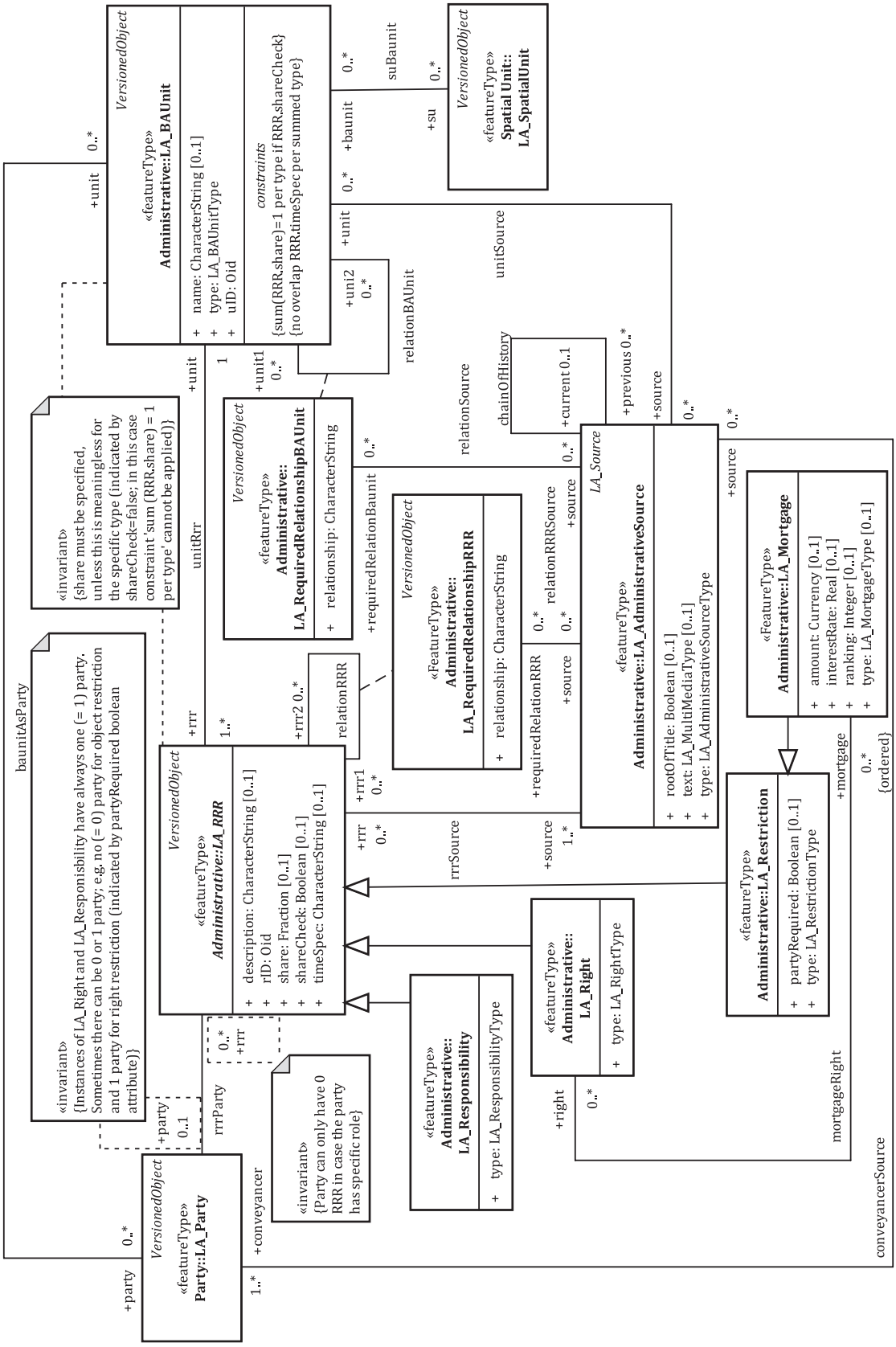


Figure 8 — Content of administrative package with associations to other basic classes

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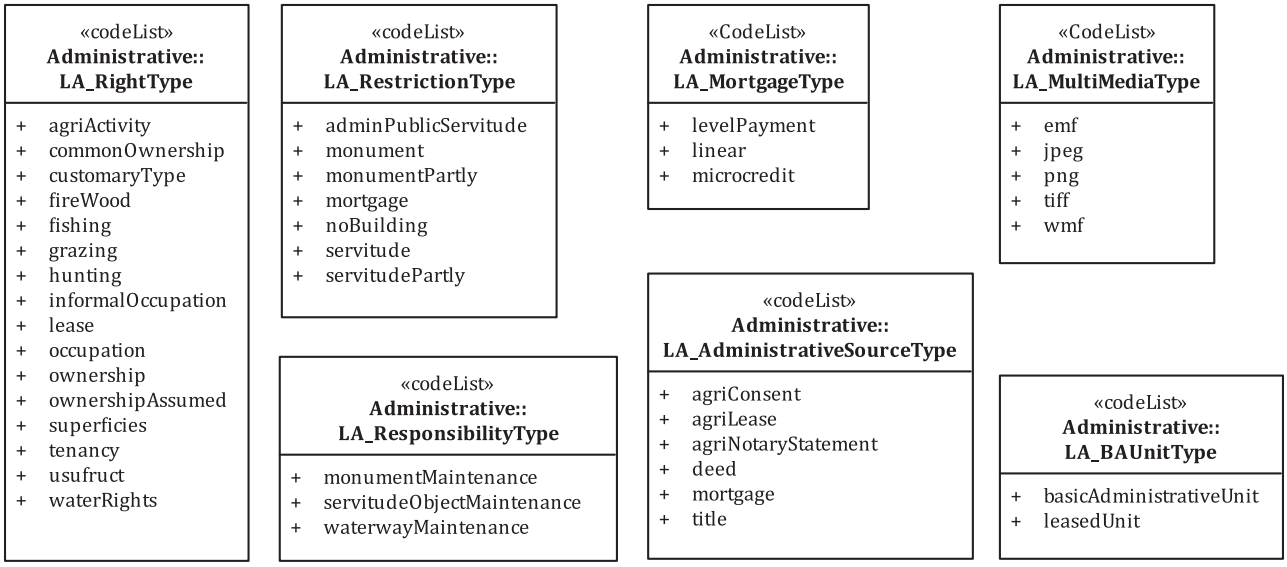


Figure 9 — Code lists of administrative package

7.4.2 LA_RRR

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

An instance of a subclass of LA_RRR 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 8.

Annex E provides legal profiles for RRR and examines the registration of rights in different systems.

11) SharesInRRR

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

Requirement 11: Holding shares in RRR shall be supported.

The attributes of LA_RRR are shown in Table 9.

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 and ISO 8601-1).

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 can be added, for example to specify legal property owner RRR in a particular jurisdiction.

NOTE 4 There can be parties without an RRR, for example surveyor, and if rights duality is not fully enforced then there can also be RRR without parties, especially for public law restrictions.

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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 an RRR in time sharing

7.4.3 LA_Right

An instance of class LA_Right is a right. LA_Right is a subclass of class LA_RRR. A right may be associated to zero or more [0..*] mortgages (i.e. a mortgage is associated to the affected basic administrative unit but it may also be specifically associated to the right which is the object of the mortgage); see Figure 8.

The attribute of LA_Right is shown in Table 10.

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

Table 10 — Attribute of LA_Right

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

7.4.4 LA_Restriction

An instance of class LA_Restriction is a restriction. LA_Restriction is a subclass of class LA_RRR. LA_Mortgage (7.4.6) is a specialization of LA_Restriction; see Figure 8.

The attributes of LA_Restriction are shown in Table 11.

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.

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

7.4.5 LA_Responsibility

An instance of class LA_Responsibility is a responsibility. LA_Responsibility is a subclass of class LA_RRR. See Figure 8.

The attribute of LA_Responsibility is shown in Table 12.

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

Table 12 — Attribute of LA_Responsibility

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

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7.4.6 LA_Mortgage

An instance of class LA_Mortgage is a mortgage. LA_Mortgage is a subclass of LA_Restriction. LA_Mortgage is associated to class LA_Right (the right that is the basis for the mortgage). A mortgage can be associated to zero or more [0..*] rights (i.e. a mortgage can be associated specifically to the right which is the object of the mortgage). In all cases, the mortgage is associated, through LA_Restriction and LA_RRR, to the basic administrative unit which is affected by the mortgage; see Figure 8.

The attributes of LA_Mortgage are shown in Table 13.

NOTE ISO 4217 can be used for the list of currencies. The currency type is specified in ISO 19103.

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

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) as described in source document
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

7.4.7 LA_AdministrativeSource

An instance of class LA_AdministrativeSource is an administrative source. LA_AdministrativeSource is a subclass of class LA_Source. An administrative source can be associated to one or more [1..*] parties (i.e. as a minimum the party playing the role of conveyancer needs to 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 Figure 8 and Figure 9.

The attributes of LA_AdministrativeSource are shown in Table 14.

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

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 can be used.

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

7.4.8 LA_RequiredRelationshipBAUnit

An instance of association class LA_RequiredRelationshipBAUnit is a required relationship between basic administrative units, see Figure 8. 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.

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

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NOTE 2 Even if the geometry of spatial units is accurate, there can 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 When a part of a spatial unit is sold, then two historic versions of BAUnits are connected in time (start date for the new BAUnit is the same as the end date of the previous BAUnit) when related to the same change.

Table 15 — Attribute of LA_RequiredRelationshipBAUnit

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

7.4.9 LA_RequiredRelationshipRRR

An instance of association class LA_RequiredRelationshipRRR is a required relationship between RRRs, see Figure 8. 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

7.5 Classes of Spatial Unit Package

7.5.1 LA_SpatialUnit

An instance of class LA_SpatialUnit is a spatial unit. A spatial unit may be associated to zero or more [0..*] basic administrative units (i.e. the spatial unit may be used to describe the extent – part of – a basic administrative unit. A spatial unit may be associated to zero or one [0..1] levels (i.e. a spatial unit can be associated to a 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 (e.g. 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. it 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 needs to be associated to one or more [1..*] spatial sources (i.e. the spatial unit needs to be supported by at least one spatial source). A spatial unit can form part of zero or one [0..1] other spatial unit(s). A spatial unit can include zero or more [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 parcels (7.5.6); see Figure 10. The example code list values of the spatial unit package are shown in Figure 8 b). Spatial units can be extended by subtyping in country profiles.

Annex F presents the integration of this document with the INSPIRE cadastral parcels.

12) ContinuumOfSpatialUnits

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 (e.g. “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) SpatialUnitIdentifiers

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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 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.

The attributes of LA_SpatialUnit are shown in Table 17.

NOTE The method "createArea( )" constructs a geometric primitive of type Collection(Surface) based on associated spatial representation (2D), see Figure 8 a). The method "areaClosed( )" checks if associated spatial representation is closed (2D). The method "computeArea( )" computes the area of associated spatial representation (2D). The method "computeVolume( )" computes the volume of associated spatial representation (3D). The method "createVolume( )" constructs a 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 the meaning of a class at a conceptual level, and are not inherited from other classes, nor defined in other ISO documents. 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.

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

7.5.2 LA_SpatialUnitGroup

An instance of class LA_SpatialUnitGroup is a spatial unit group. A spatial unit group is made of one or more [1..*] parts/elements (which can be spatial units, or spatial unit groups, or a combination of spatial units and spatial unit groups). A spatial unit group is part of zero or one [0..1] larger spatial unit group(s), which can again be part of zero or one [0..1] larger spatial unit group(s), etc. See Figure 10.

The attributes of LA_SpatialUnitGroup are shown in Table 18.

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

Table 18 — Attributes of LA_SpatialUnitGroup

Attribute name	Type	Cardinality	Description
hierarchyLevel	Integer	1	The level in the hierarchy of an administrative, or zoning sub-division
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

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7.5.3 LA_LegalSpaceBuildingUnit

An instance of class LA_LegalSpaceBuildingUnit is a building unit. LA_LegalSpaceBuildingUnit is a subclass of class LA_SpatialUnit; see Figure 10.

The attributes of LA_LegalSpaceBuildingUnit are shown in Table 19.

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.

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

7.5.4 LA_LegalSpaceUtilityNetworkElement

An instance of LA_LegalSpaceUtilityNetworkElement is a utility network element. LA_LegalSpaceUtilityNetworkElement is a subclass of class LA_SpatialUnit, see Figure 10.

The attributes of LA_LegalSpaceUtilityNetworkElement are shown in Table 20.

NOTE Networks are implicitly connected. In LA perspective registration is typically concerning 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.

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

7.5.5 LA_LegalSpaceCivilEngineeringElement

An instance of LA_LegalSpaceCivilEngineeringElement is an infrastructure. LA_LegalSpaceCivilEngineeringElement is a subclass of class LA_SpatialUnit, see Figure 10.

The attributes of LA_LegalSpaceCivilEngineeringElement are shown in Table 21.

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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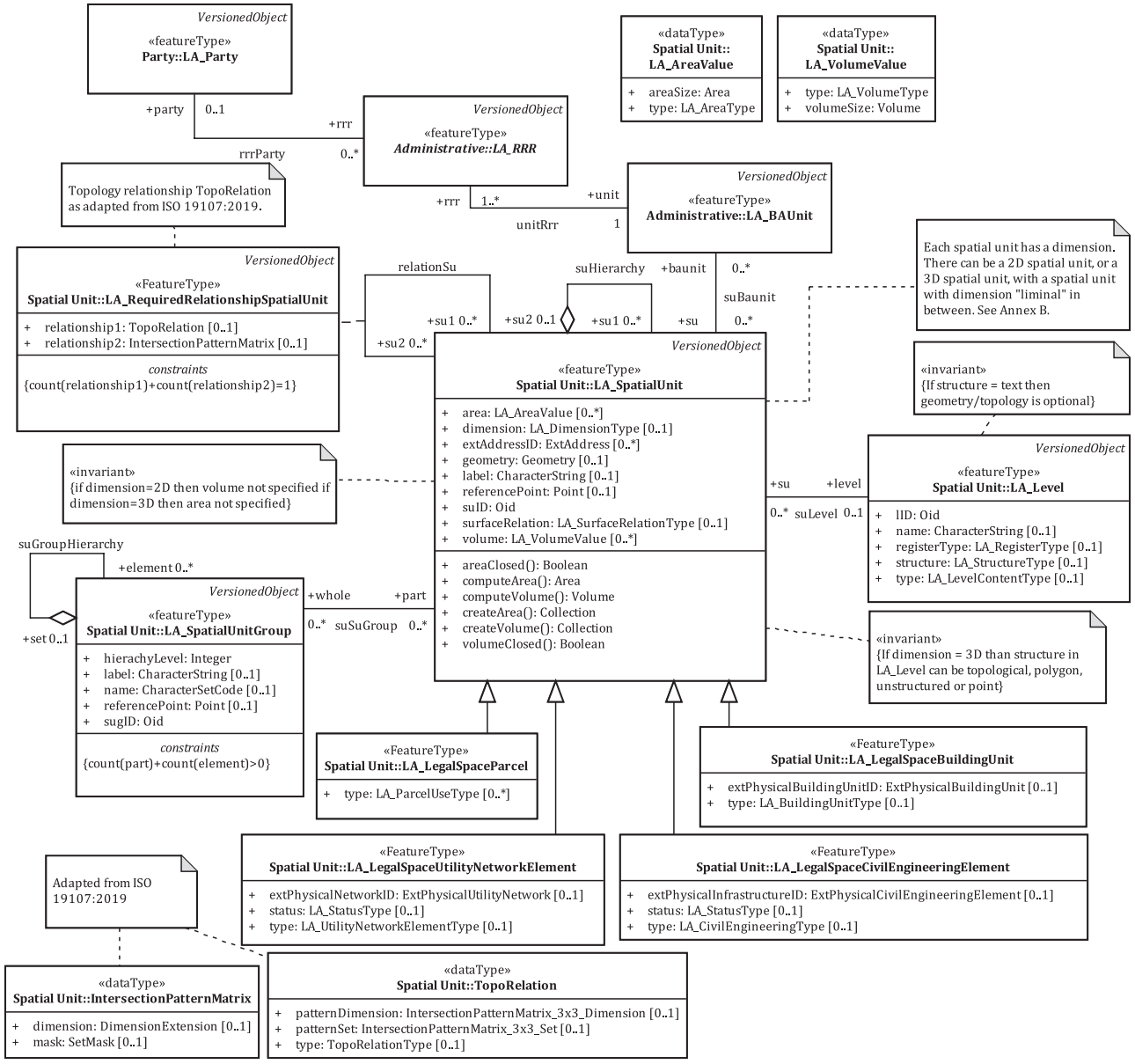


Figure 10 — Content of spatial unit package with associations to other basic classes

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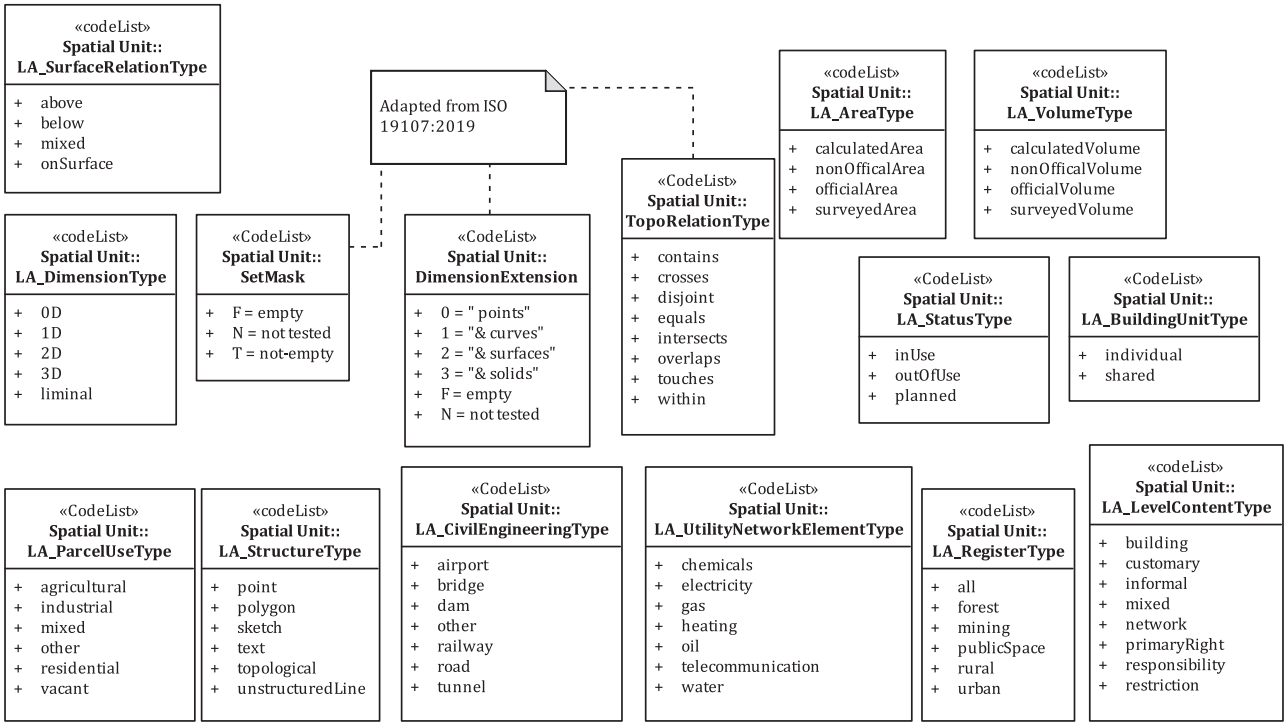


Figure 11 — Code lists of spatial unit package

7.5.6 LA_LegalSpaceParcel

An instance of LA_LegalSpaceParcel is a parcel. LA_LegalSpaceParcel is a subclass of class LA_SpatialUnit; see Figure 10. The attribute of LA_LegalSpaceParcel Parcel is shown in Table 22.

Table 22 — Attributes of LA_LegalSpaceParcel

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

7.5.7 LA_Level

An instance of class LA_Level is a level. LA_Level is associated to class LA_SpatialUnit; see Figure 10.

The attributes of LA_Level are shown in Table 23.

EXAMPLE Levels are demonstrated in instance level cases; see Annex D, Figures D.2, D.12, D.13, D.16, D.20, D.22, D.23 and D.24.

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

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7.5.8 LA_RequiredRelationshipSpatialUnit

An instance of association class LA_RequiredRelationshipSpatialUnit is a required relationship between spatial units; see Figure 10.

The attribute of LA_RequiredRelationshipSpatialUnit is shown in Table 24.

NOTE The cardinality of TopoRelation or IntersectionPatternMatrix is required to be equal to 1.

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

7.5.9 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.

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. For information on the dimensionally extended 9 intersection model (DE-9IM), see ISO/IEC 13249-3.

Table 27 — Attributes of TopoRelation

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

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.

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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, 10.8.6.1
dimension	DimensionExtension	0..1	The dimension extension of intersection pattern matrix; see ISO 19107:2019, 5.1.3

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.

7.6 Classes of Surveying and Representation Sub-package

7.6.1 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 needs to be associated to zero or more [0..*] spatial sources, see Figure 12. The example code list values of the surveying and representation of sub-package are shown in Figure 13.

The attributes of LA_Point are shown in Table 29.

NOTE The method "getTransResult( )" returns the transformed point (Point), and is not inherited from other classes, nor defined in other ISO documents; see Figure 12.

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 physical boundary mark in the field
originalLocation	Point	1	The calculated coordinates, based on measurements and observations
pID	Oid	1	The point identifier
pointType	LA_PointType	1	The type of point
productionMethod	LI_Lineage	0..1	The lineage (ISO 19115-1)
transAndResult	LA _Transformation	0..*	Transformation and transformed location

7.6.2 LA_BoundaryFaceString

An instance of class LA_BoundaryFaceString is a boundary face string. LA_BoundaryFaceString is associated with 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 needs to be defined by two or more [2..*] points (as a minimum, a boundary starts and ends at a point, i.e. a straight line).

NOTE 1 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

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may be associated to zero or more [0..*] spatial sources i.e. the boundary of a spatial unit can be described on zero or more spatial sources (on the spatial source creating the spatial unit and on the spatial source creating the neighbouring spatial unit); see Figure 12.

The attributes of LA_BoundaryFaceString are shown in Table 30.

NOTE 2 The geometry is either derived from associated class LA_Point or based on captured linear geometry.

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

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

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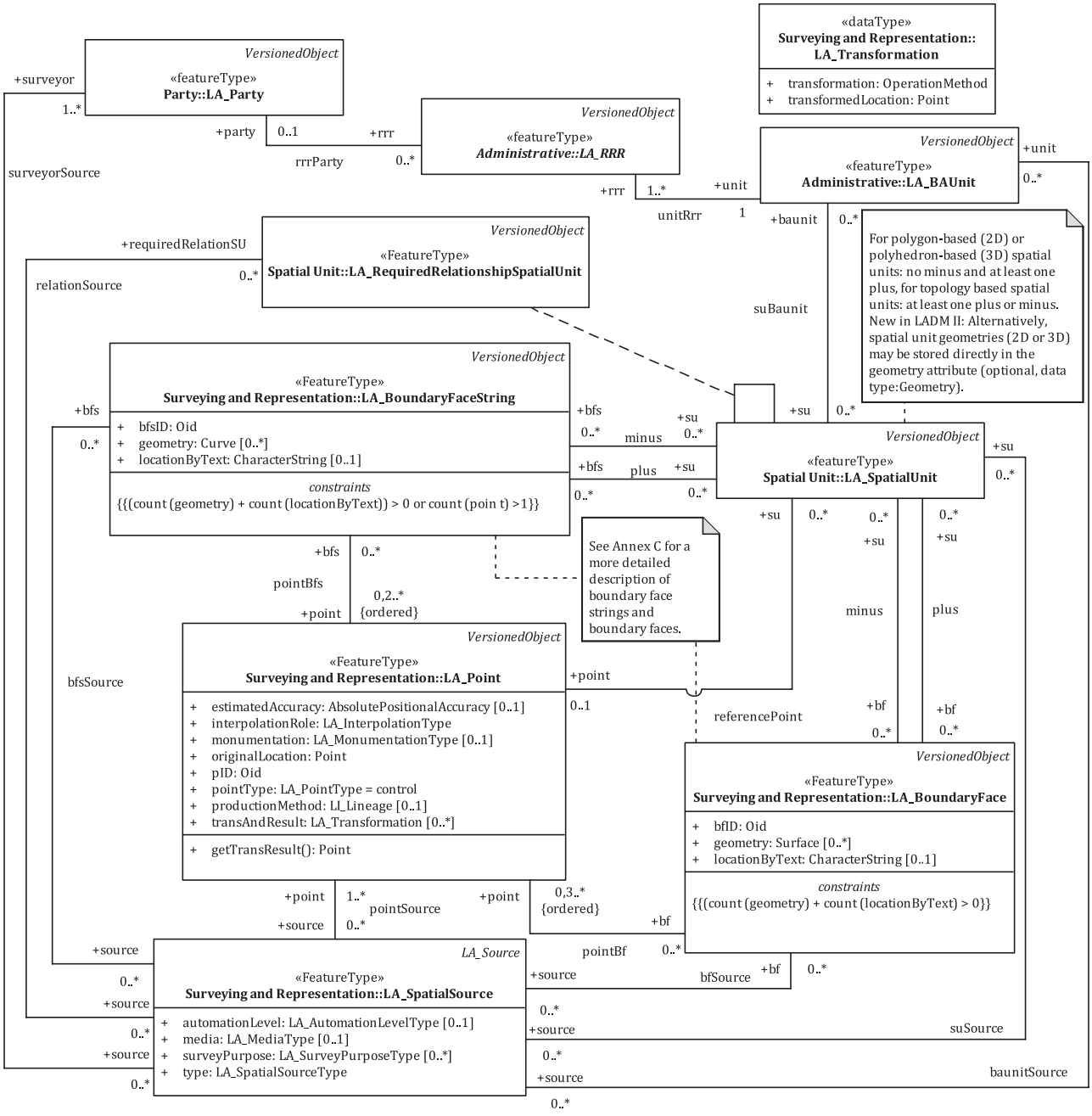


Figure 12 — Content of surveying and representation sub-package with associations to other basic classes (1)

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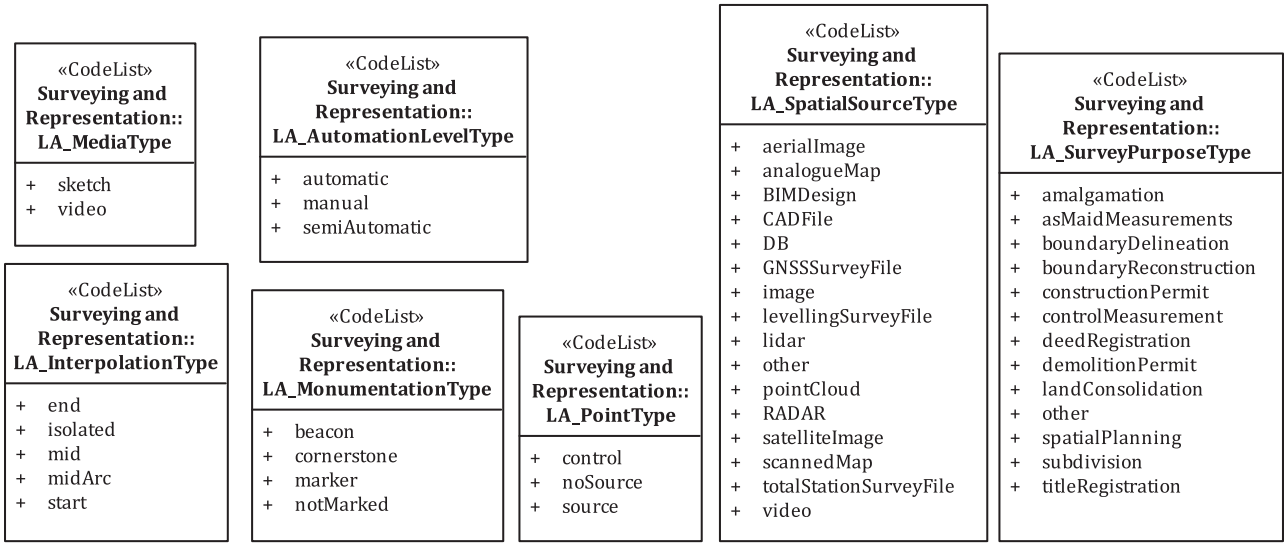


Figure 13 — Data type and code lists of surveying and representation sub-package (1)

7.6.3 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 needs 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 zero or more spatial sources (on the spatial source creating the spatial unit and the spatial source creating the neighbouring spatial unit). The orientation of the boundary that is equal to the orientation of the spatial unit is the "+" association, otherwise "–"; see Figure 12.

The attributes of LA_BoundaryFace are shown in Table 31.

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.

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

7.6.4 LA_SpatialSource

An instance of class LA_SpatialSource is a spatial source. LA_SpatialSource is a subclass of class LA_Source. A spatial source needs 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 needs 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, needs to be specified). See Figure 10 and Figure 11.

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The optional association class connecting LA_Party and LA_SpatialSource denotes the different roles of a survey executor; see Figure 12.

14) SpatialSourceBasedMaps

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.

The attributes of LA_SpatialSource are shown in Table 32.

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.

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

7.6.5 LA_SurveySource

An instance of class LA_SurveySource is a survey source. A set of measurements (such as distances, bearings, GNNS observations, etc.) may be obtained via various survey techniques and stored on designated media. LA_SurveySource is a subclass of class LA_SpatialSource. See Figure 14. The example code list values of the surveying and representation sub-package are shown in Figure 15.

15) DataAcquisitionMethods

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) CadastralReferenceSystem

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

Requirement 16: Efficient LASs compliant with this document 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 will potentially 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) DataQuality

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

Requirement 17: The cadastral information shall be as complete as possible, reliable (i.e. 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 shall be ready to keep the information

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up to date. Data quality of spatial data may be improved in a later stage of development of a LAS; this shall 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.

The attributes of LA_SurveySource are shown in Table 33.

NOTE The class survey LA_SurveySource and some of its subclasses are adapted from/inspired by 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.

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)
accuracyLevel	LA_ObservationsAccuracyType	0..1	The level of observation accuracy expected
equipmentID	ExtEquipment	0..1	Information on the equipment used in survey

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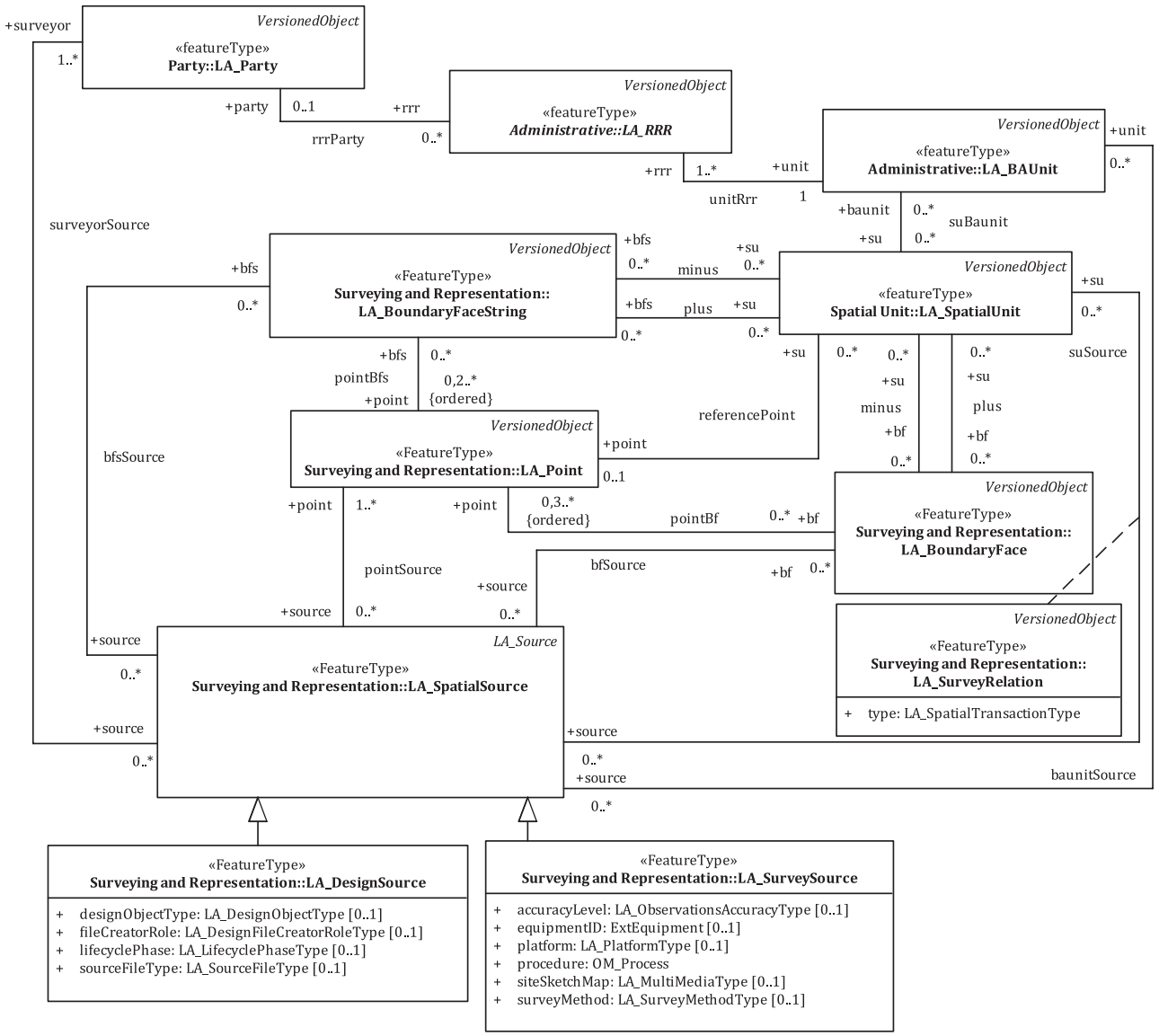


Figure 14 — Basic classes of the surveying and representation sub-package with associations to other basic classes (2)

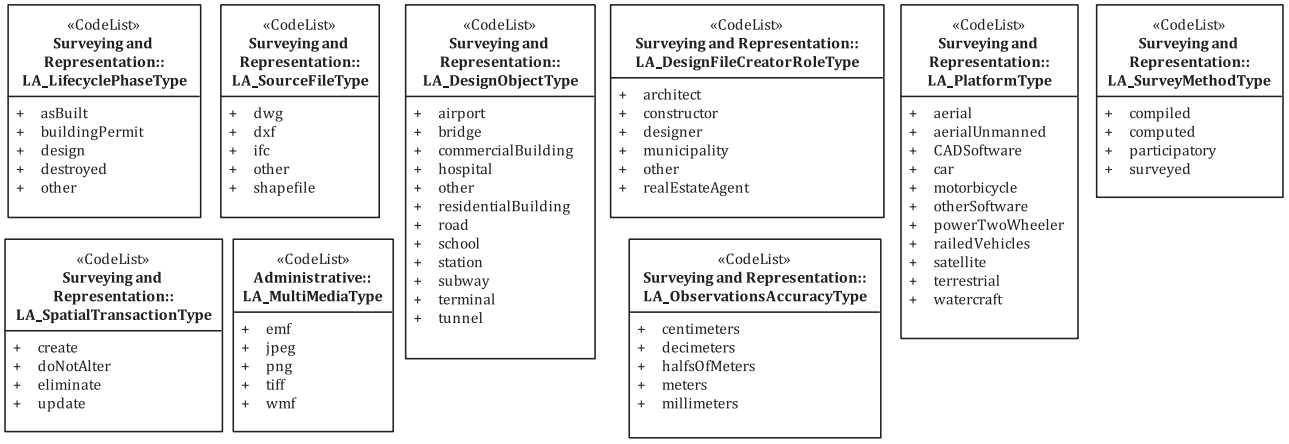


Figure 15 — Code lists of the surveying and representation sub-package (2)

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7.6.6 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 a subclass of class LA_SpatialSource. See Figure 14.

The attributes of LA_DesignSource are shown in Table 34.

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

7.6.7 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 14.

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 ISO 19156, 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 14.

7.6.8 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 a subclass of class LA_SurveySource. See Figure 16. The example code list values of the surveying and representation sub-package are shown in Figure 17.

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

7.6.9 LA_LevelObservation

An instance of class LA_LevelObservation is a survey source obtained by level observation. LA_LevelObservation is a subclass of class LA_SurveySource. See Figure 16.

The attributes of LA_LevelObservation are shown in Table 37.

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Table 37 — Attributes of LA_LevelObservation

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

7.6.10 LA_AngularObservation

An instance of class LA_AngularObservation is a survey source obtained by angular observation. LA_AngularObservation is a subclass of class LA_SurveySource. See Figure 16.

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	Information about the angular observation

7.6.11 LA_ImageObservation

An instance of class LA_ImageObservation is a survey source obtained by image-based observation. LA_ImageObservation is a subclass of class LA_SurveySource. See Figure 16.

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	Information about the image-based observation

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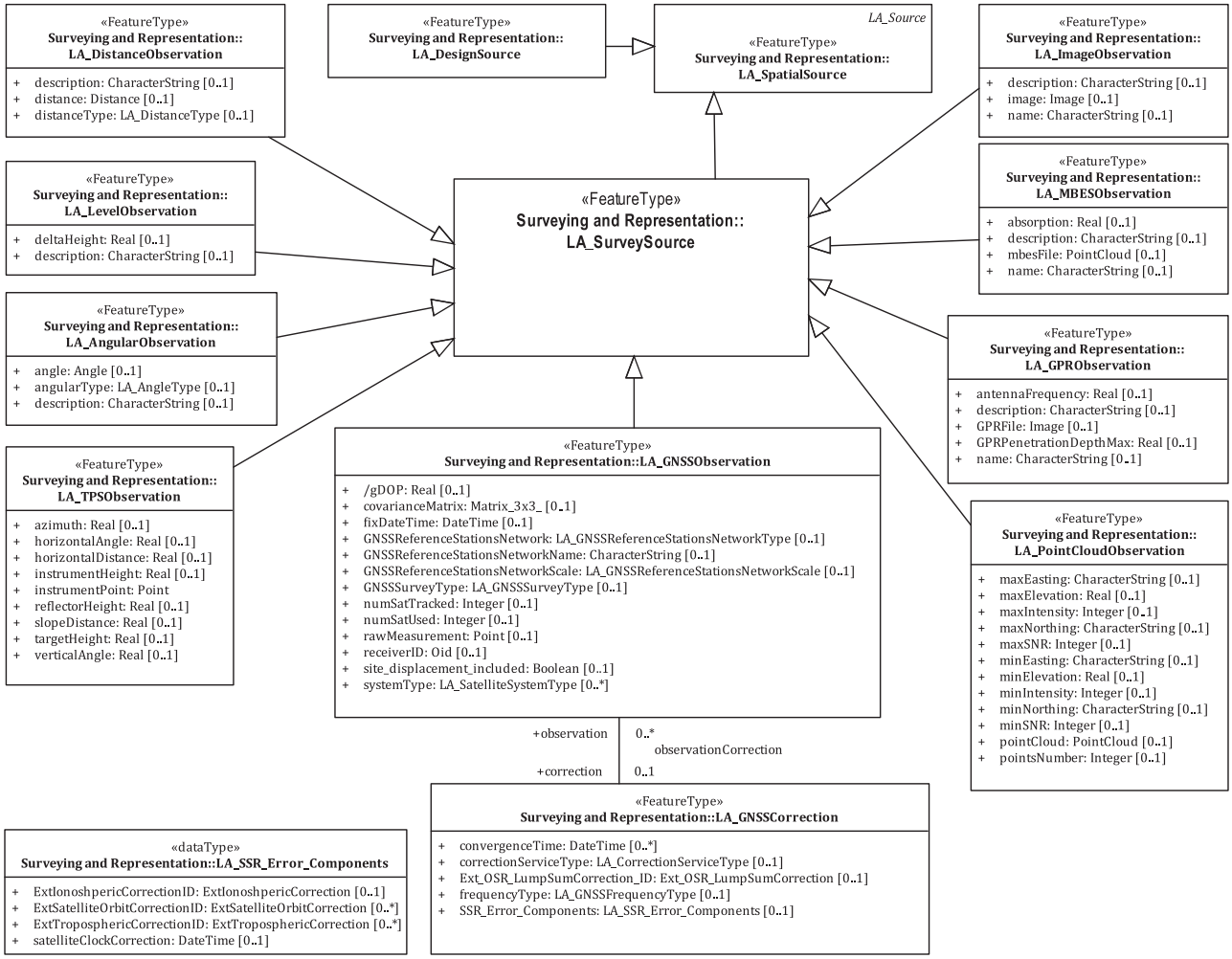


Figure 16 — Content of the surveying and representation sub-package (3)

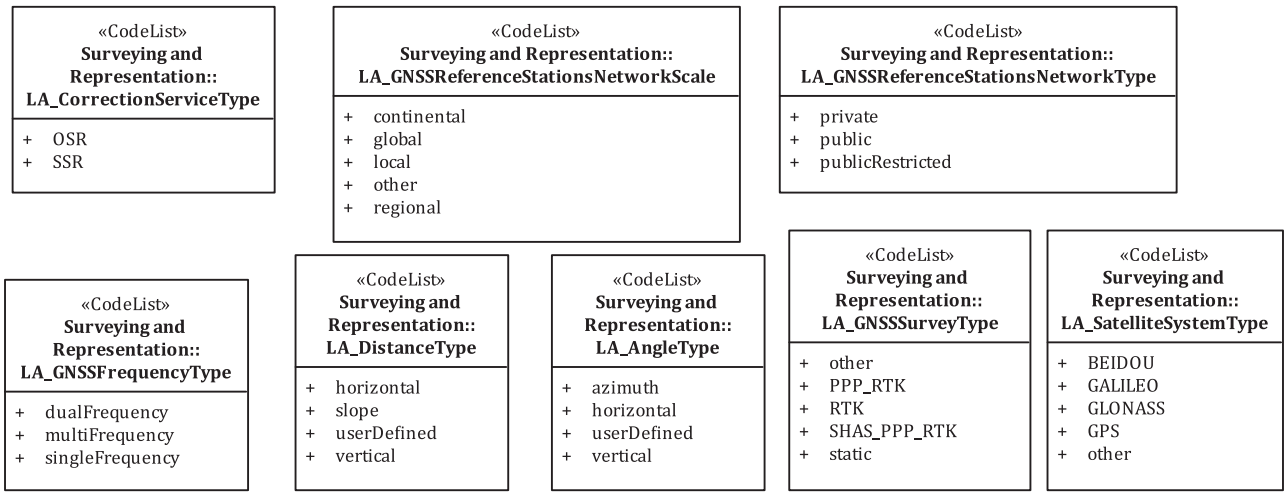


Figure 17 — Code lists of the surveying and representation sub-package (3)

7.6.12 LA_TPSObservation

An instance of class LA_TPSObservation is a survey source obtained using total-station. A TPSObservation contains angular and distance observation from the InstrumentPoint to the TargetPoint. LA_TPSObservation is a subclass of class LA_SurveySource. See Figure 16.

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The attributes of LA_TPSObservation are shown in Table 40.

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

7.6.13 LA_PointCloudObservation

An instance of class LA_PointCloudObservation is a survey source obtained using point clouds observation. LA_PointCloudObservation is a subclass of class LA_SurveySource. See Figure 16.

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

7.6.14 LA_GNSSObservation

An instance of class LA_GNSSObservation is a survey source obtained using GNSS receivers. A LA_GNSSObservation contains all the data related to the GNSS observation. It is a subclass of class LA_SurveySource. See Figure 16.

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 have been tracked from the rover position
numSatUsed	Integer	0..1	The number of satellites that have 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 an SSR position (e.g. Earth tides) is already included
rawMeasurement	Point	0..1	The raw result of the observation

7.6.15 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 a subclass of class LA_GNSSObservation. See Figure 16.

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

7.6.16 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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