Overview of Developments of Edition II of the Land Administration Domain Model

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SUMMARY

The International Organization for Standardization (ISO) standard 19152 Land Administration Domain Model (LADM) was published in its first edition in 2012 to address basic information-related components of Land Administration (LA). The LADM is a knowledge domain standard capturing the semantics of the LA domain. Even if the Edition I of the standard had a broad vision, the emphasis was mainly on land tenure and spatial units (parcels). The marine spaces, as well as the aspects of land value and land use were purposely left aside of the scope of the standard.

It is pertinent to note that LADM is designed as generic as possible to support land administration and it's development in a region or country.-Specific extensions can be defined in local profiles. In fact, the LADM Edition I is widely utilized and has been applied for various cases and purposes.

The second edition of the standard will be published as multipart. Part 1 presents the Generic Conceptual Model of the LADM, while Part 2 focuses on Land Registration will be largely based on LADM Edition I but has been extended with a refined survey model, 3D spatial profiles and semantically enriched code lists. Part 3 on Marine Georegulation will brings value by harmonizing the description of rights, restrictions and responsibilities in the marine domain - aligned with land concepts in order to provide seamless land/marineLA. LADM Part 3 is foundedThe IHO standard S-121 'Marine Limits and Boundaries', is the basis for LADM Part 3. Part 4 is about Valuation Information in line with land administration and the characteristics and semantics of valuation registries usually maintained by public authorities. Part 5 is about Spatial Plan Information and includes planned land use (zoning) represented into rights, restrictions and responsibilities. Lastly, Part 6 is planned to be about the implementation of the LADM, with the active participation of the Open Geospatial Consortium (OGC).

This paper focuses on the current status of the developments of LADM Edition II. It should be noted that these developments are ongoing and under discussion and may undergo changes based on comments and observations during the voting rounds.

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1. INTRODUCTION

The Land Administration Guidelines developed by the United Nations Economic Commission for Europe (UNECE) include a widely accepted definition of land administration: "*the processes of recording and disseminating information about the ownership, value and use of land and its associated resources*" (UNECE, 1996). Based on this definition the LADM standard defines land administration as the "*process of determining, recording and disseminating information about the relation between people and land".* Land is defined in the LADM Edition II as the "*spatial extent that is defined by RRRs [via baunit] and encompass the surface of the earth, strata, sub-strata or the marine environment".* Inclusion of the marine georegulation, land value information, as well as spatial plan information is well aligned to those definitions. It can be indicated from these definitions that LA is a large field with several functions. Those functions are introduced in Enemark (2006). In all these extensions the 3D representations play an important role.

The LADM (ISO, 2012 and Lemmen et al. 2015)) and Social Tenure Domain Model (STDM) (Lemmen, 2010) are also applicable in relation to the implementation of relevant parts of international guiding documents such as the New Urban Agenda (UN, 2017), the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (FAO, 2012), the continuum of land rights as from UN-Habitat (UN-Habitat, 2008, Teo and Lemmen, 2013), the Fit-for-purpose land administration: guiding principles for country implementation (FIG/World Bank, 2014 and UN-Habitat/GLTN/Kadaster, 2016) and the 'Framework for Effective Land Administration: A reference for developing, reforming, renewing, strengthening, modernizing, and monitoring land administration' from the Expert Group on Land Administration and Management of the UN-GGIM (UN GGIM, 2020). All those fit well into the context of implementation of the Sustainable Developments Goals (SDGs).

This paper focuses on the structure of the second edition and its operational capabilities in its Parts 1, 2, 4 and 5 (under development, the authors are involved in this development). In its final version the contents of the standard may be different compared to this paper. The remainder of the paper is organized as follows: first, background information is presented in Section 2. Then, the paper focuses on the developments and related discussions of the four Parts of the Edition II, starting with Part 1 (Section 3), while in Section 4 the Part 2 is presented. Furthermore, Section 5 presents the proposed valuation information (part 4) and spatial plan

information (part 5) is described in Section 6. Status of development is provided in Section 7 and conclusions are presented in the final Section 8. Note: Part 3 is not discussed in this paper.

2. BACKGROUND

Although the LADM Edition I is extensively used (Kalogianni et al., 2021) and is applicable for various use cases and purposes, ISO rules prescribe periodic revision. This starts by collection responses from ISO/TC 211 Member States concerning the needs for updated and extended capabilities. During a Meeting of the UN-GGIM Expert Group on Land Administration and Management that was held in 2017, in Delft, The Netherlands it was concluded that a revision of the LADM Edition I is required in order to provide better tools in support to tenure security with better coverage of LA (UN-GGIM, 2019). As a result of the voting on the systematic review of ISO 19152:2012 (March 2018) it became clear that the majority of the ISO/TC 211 P-members expressed their wish for such a revision. The ISO Stage 0 project started in May 2018 during the 46th Plenary Meeting Week of ISO/TC 211 in Copenhagen, Denmark.

In order to revise LADM Edition I, several FIG LADM Workshops were organized where options for improvement and extensions were discussed: one in Delft, the Netherlands, in March 2017 (FIG, 2017), one in Zagreb, Croatia in April 2018 (FIG, 2018a), one in Kuala Lumpur, Malaysia in October 2019 (FIG 2019), one online in June 2021 (FIG, 2021) and one in Dubrovnik, Croatia in March/April 2022 (FIG, 2022). See further inputs for Edition II in FIG, 2018b and in Lemmen et al., (2019) and Lemmen et al., (2020). From those, the integration of valuation information and spatial plan information within the LADM has been considered appropriate, together with the provision of land administration in 3D (below, on and above the surface of the earth) on land and sea, as well as further mechanisms to exchange information (for example based on OGC's LandInfra/ InfraGML),), etc.

In the 48th Plenary Meeting Week of ISO/TC 211 in 2019, LADM Edition II was proposed to be developed as multi-part. The following structure for the multi-part option (as multiple coherent packages with every part in separate standard) was agreed:

- Part 1 – Generic Conceptual Model
- Part 2 – Land Registration
- Part 3 – Marine Georegulation
- Part 4 – Valuation Information
- Part 5 – Spatial Plan Information
- Part 6 – Implementation Aspects

The experts involved in the revision are from academia, industry, standardization bodies and professional organisations. Specifically, collaboration is or will be organized between the International Standardisation Organisation (ISO), the International Federation of Surveyors

(FIG), the Open Geospatial Consortium (OGC), UN-Habitat, the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM), the Global Land Tool Network (GLTN), the International Hydrographic Organisation (IHO) and the Royal Institute of Chartered Surveyors (RICS), etc. The cooperation OGC - ISO is expected to contribute to effective implementation approaches. In this scene, a White Paper on Land Administration has been prepared by the Domain Working Group Land Administration of the OGC (OGC, 2019).

The decision to publish LADM Edition II as multipart had as a consequence that six standards will be developed. Therefore, a New Work Item Proposal (NWIP) has to be formulated for each Part. In a multi-part approach each professional group involved in the LA processes (e.g., surveyors and registrars, valuers, planners, etc.) can be better organised during the development of the standard. In addition, it may be easier to collaborate with the relevant organizations, for example, FIG Commissions 3 (Spatial Information Management) and 7 (Cadastre and Land Management) for Part 2, Commission 8 (Spatial Planning and Development) for Part 5 and Commission 9 (Valuation and the Management of Real Estate) for Part 4.

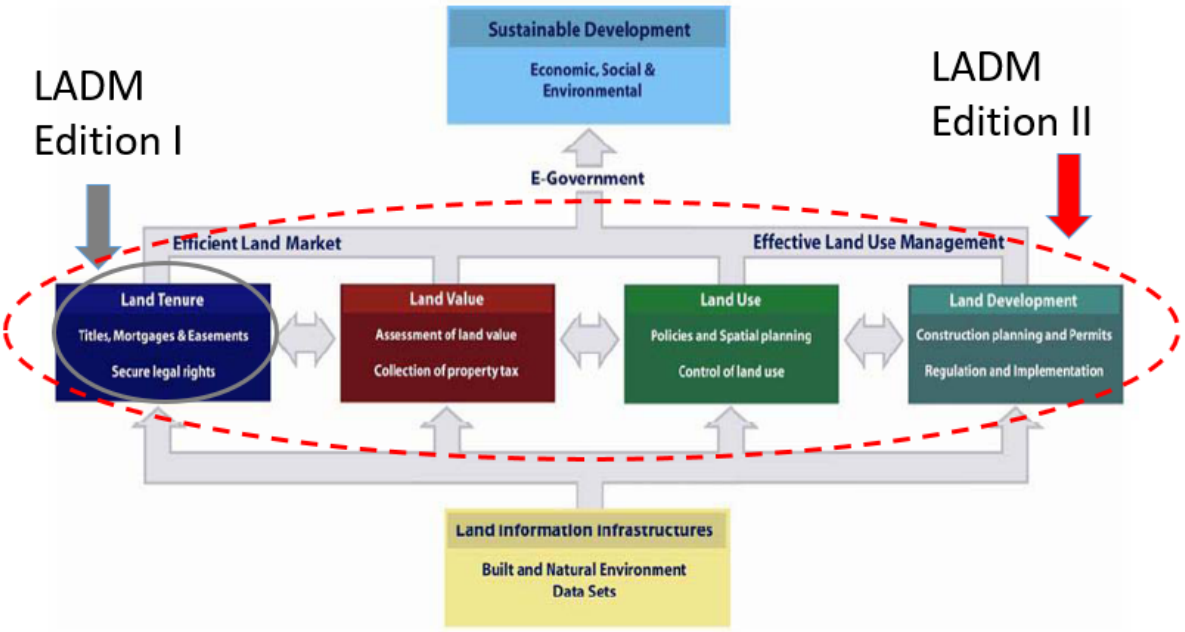

Figure 1. Land Administration paradigm and LADM scope (adapted from Enemark, 2006)

The main purpose of this paper is to inform the international community on how the LADM Edition II development is ongoing. This paper is a follow up of Lemmen et al. (2020) and Lemmen et al. (2021) – but for the first time it is a complete overview when it is about LADM in support to land tenure, land value and land use, as in the definition of Land Administration in UNECE, 1996 and as functions in the Land Administration paradigm (Enemark, 2006) see Figure 1. Marine Georegulation and implementation will be added in future reporting papers.

3. LADM EDITION II PART 1 - GENERIC CONCEPTUAL MODEL

The Part 1 will be a high-level umbrella standard that supports all the other parts of the LADM Edition II. Part 1 will include the fundamental notions and will define the basic components and relations shared by all objects created by land administration and provides an overview of all Parts. The Part 1 will not only be backward compatible with the previous version of the LADM but also with the IHO S-121 Maritime Limits and Boundaries standard (IHO, 2016), that will be used as basis when developing the Part 3.

Part 1 provides the definitions, a general overview of the model in its individual packages and a more detailed overview of the *LA_Source,* with a backwards compatible integrated administrative and spatial source added. Also, *VersionedObject* class is included, in Part 1 with standardized support for the bi-temporal model with intervals for both system and real-world times (Thompson and van Oosterom, 2021).

Considering a comment submitted by the Standards Council of Canada (SCC), a new term with a wider meaning is introduced 'georegulation', which can be defined as an activity to delimit and assert control over 2D, 3D or 4D represented geographical (and temporal) spaces through regulations. Some of the geometry and spatial unit related definitions included in the LADM Edition I will not be defined in the Part 1 since they are not applicable for the certain other Parts (e.g., marine space). These definitions are boundary, boundary face, boundary face string, face, level and liminal spatial unit. In addition, the definition of right is changed as '*formal or informal entitlement to own or do something*'.

The LADM is organized as a set of application schemas. Each application schema has its own namespace and is organised into a set of packages and (sub)packages. See Figure 2. A (sub)package is a group of classes, with a certain degree of cohesion that facilitates the maintenance of different data sets by various organizations. Different organizations have their own responsibilities in data maintenance and supply, but may communicate on the basis of standardized administrative and technical update processes.

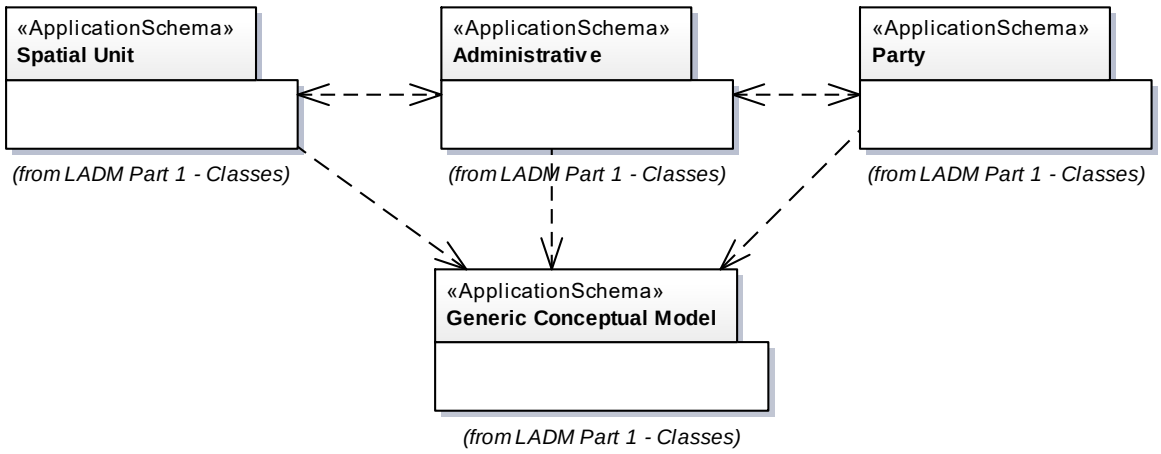

Figure 2. (Sub)Packages of the core LADM

The Surveying and Representation Subpackage of the LADM Edition I will not be included in the main text of the Part 1 since it is not applicable for Marine Georegulation, but is included in Part 2. As Part 1 is designed as a high-level standard, not all the classes of these packages are included. For example, LA_Mortgage from the Administrative Package and LA_LegalSpaceBuildingUnit and LA_LegalSpaceUtilityNetwork from the Spatial Unit Package are not included in the main text of the Part 1.

Part 1 of ISO 19152 defines the high-level structure (global view) for the complete area of Land Administration/ Georegulation. The generic conceptual model of the LADM is based on four basic classes, all inheriting from LA_VersionedObject (and associated to LA_Source) (see Figures 3 and 7):

- Class LA_Party,
- Class LA_RRR,
- Class LA_BAUnit, and:
- Class LA_SpatialUnit.

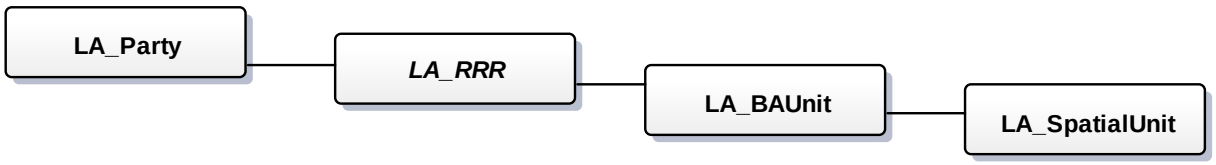

Figure 3. Generic Conceptual Model- basic classes of the core LADM

The main class of the Party Package is the basic class LA_Party. LA_Party has a specialization: LA_GroupParty . Between LA_Party and LA_GroupParty there is an optional association class: LA_PartyMember, see Figure 4.

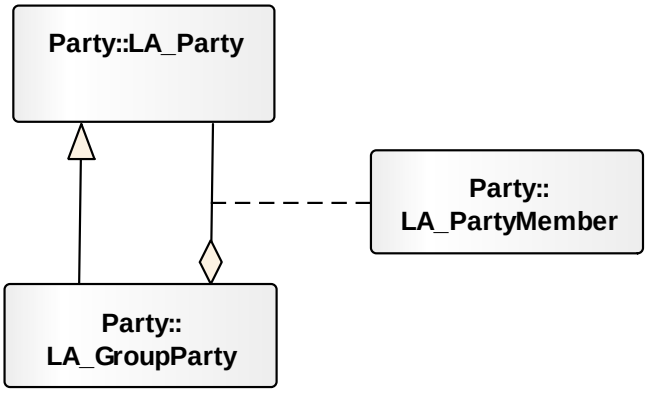

Figure 4. Classes of Party Package

The main classes of the Administrative Package are basic classes LA_RRR and LA_BAUnit. See Figure 5. LA_RRR is an abstract class with three specialization classes: LA_Right, LA_Restriction and LA_Responsibility. The type of right, restriction and responsibility

depends upon the application area and will be described in more detail in each of the other Parts of this standard.

The BAUnit is one of the core classes of the model and defines the elements upon which RRRs apply. All rights, restrictions and responsibilities are based on an administrative source.

The class LA_RequiredRelationshipBAUnit allows for creating instances of relationships between BAUnits. The Administrative package will be partly introduced in Part 2 – Land Registration. This concerns the class LA_Mortgage.

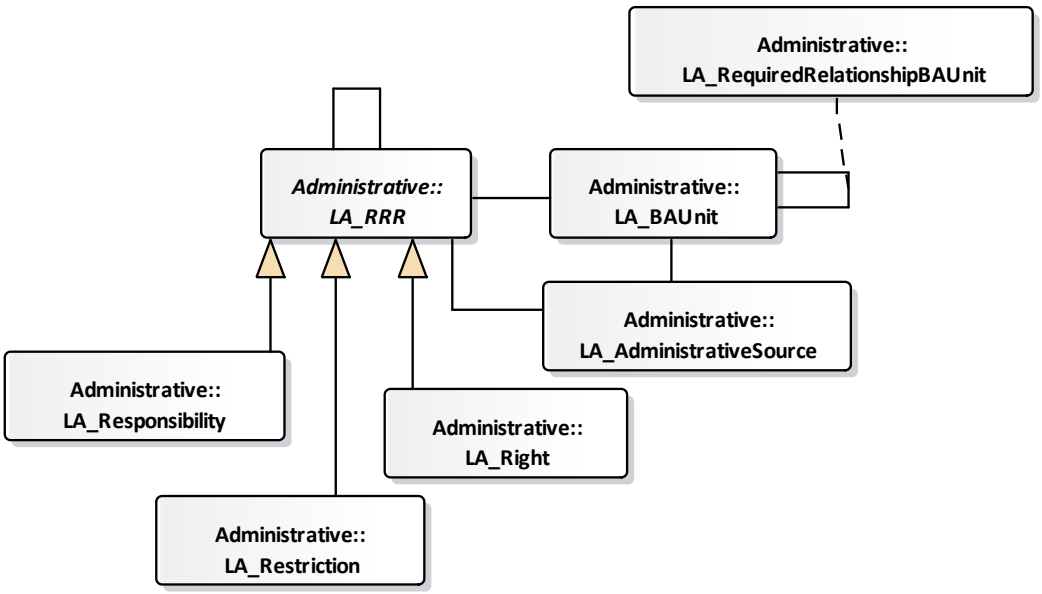

Figure 5. Classes of Administrative Package

The main class of the Spatial Unit Package is the basic class LA_SpatialUnit, see Figure 6.

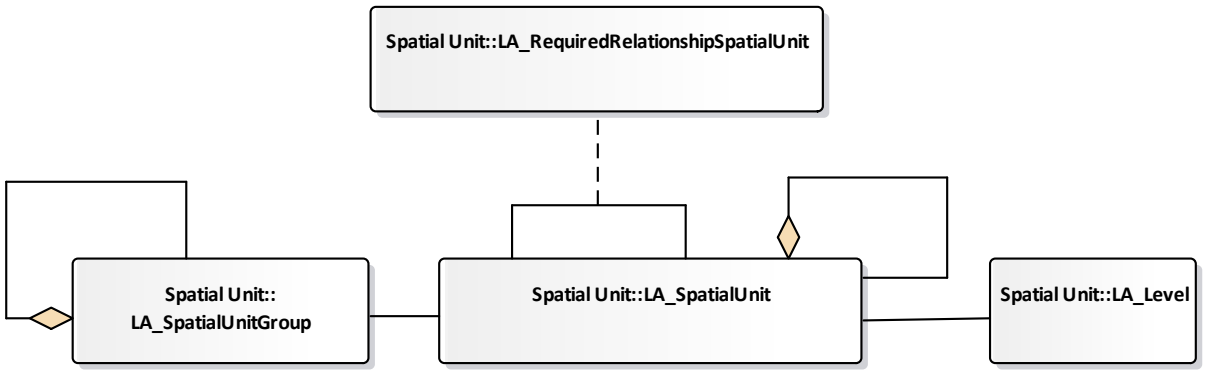

Figure 6. Classes of Spatial Unit Package

Spatial units may be grouped into two forms. First as spatial unit groups, second as sub spatial units (i.e., sub parcels), that is a grouping of a spatial unit into its parts. This is realized by an aggregation relationship of LA_SpatialUnit onto itself, (Figure 6). Parts, in their turn, may be grouped into subparts (sub sub-parcels), and so on. A level is a collection of spatial units with a geometric and/or topologic and/or thematic coherence, which is another approach that allows grouping of spatial units. Required relationships are explicit spatial relationships between spatial units.

Part 1 provides a general overview of the model in its packages as indicated above and a more detailed description of the VersionedObject and LA_Source classes (see Figure 7). VersionedObject is an abstract class and provides (optional) begin and (optional) end Lifespan and Real-World Timestamps (optional) to the inheriting classes (see Figure 8). The class VersionedObject is used in the LADM to manage and maintain historical data in the database (ISO, 2012). History requires that inserted and superseded data, are given a timestamp. All LADM classes inherit from VersionedObject (except for LA_Source). In this way, the contents of the database can be reconstructed, as they were at any historical moment (Thompson and Oosterom, 2021).

There is one difference between the VersionedObject class in Editions I and II: the cardinality of the beginLifeSpanVersion changed from mandatory (1) to optional (0..1) and value type for this characteristic is defined as ‘real_world_time’.

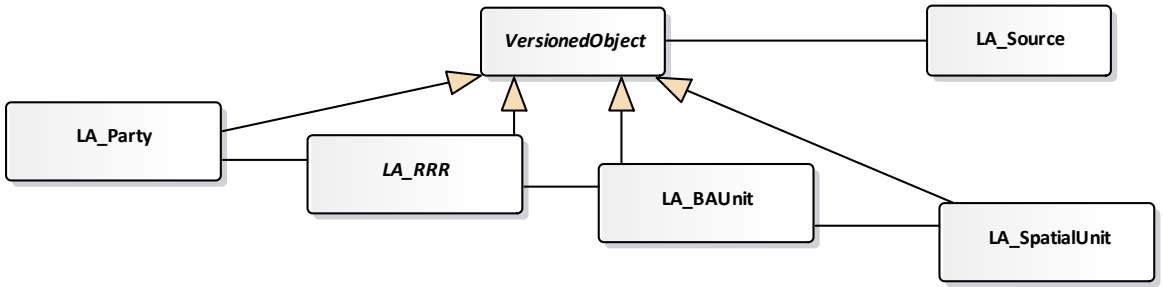

Figure 7. Basic classes of the core LADM with versioned object

The LA_Source class is introduced in Part 1 in order to support any kind of source. This class represents the event causing the changes in the registration (ISO, 2012). All the dates and times are system (or database) time, corresponding to the moment where the event was processed and stored in the system (Thompson and Van Oosterom, 2021).

With the associations between VersionedObject and LA_Source, instances of sources can now be versioned, unlike the previous Edition of the LADM. Constraints assure correspondence of dates and times in VersionedObject and LA_Source (Figure 8).

In addition, VersionedObject and LA_Source have a second set of optional temporal attributes (beginValidLifespanVersion, endValidLifespanVersion, and acceptance), representing to the corresponding valid times in the real world (Thompson and Van Oosterom, 2021).

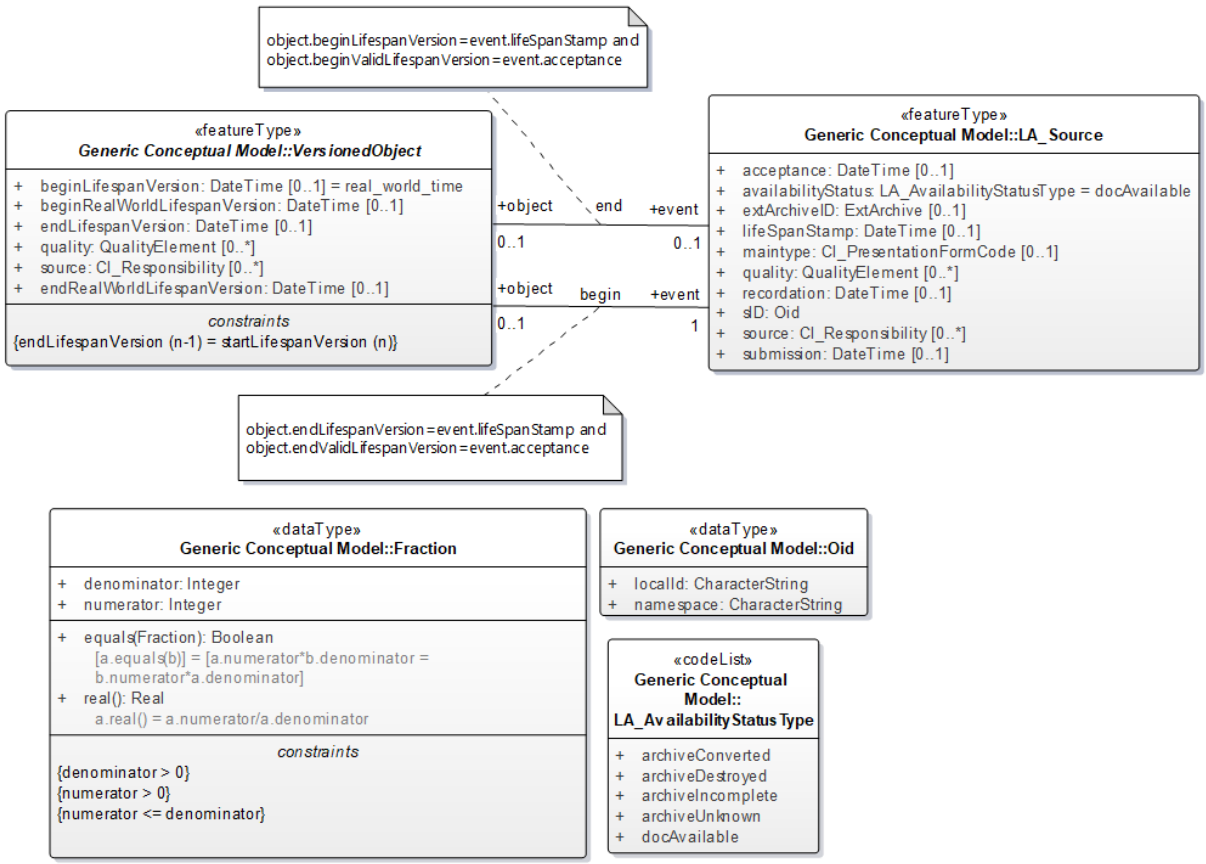

Figure 8. Generic Conceptual Model classes - Source, Versioned Object, Fraction and Oid

Moreover, Part 1 introduces two more generic data types: Fraction and Oid (see Figure 8). The former one provides support for fractions (e.g., ½ or ¾), written as a pair of numbers, numerator and denominator, and the latter one provides support for object identifiers (ISO, 2012).

Part 1 plays a special role by providing the common basis relevant for all Parts but also giving in the Annex C a synchronized overview, that is the model at class level, of the Parts 2 to 5.

4. LADM EDITION II PART 2 – LAND REGISTRATION

The LADM Edition I concentrated on Land Registration, which will now be addressed in the Part 2 of the LADM Edition II. Some of the existing Parts of LADM Edition I are being refined in Part 2. The goal is that these refinements will add more semantics to the LADM.

In addition to the classes introduced in Part 1, as introduced in Section 2, the Land Registration contains the LA_Mortgage subclass of LA Restriction and the LA_Mortgage is associated to the LA_Right on which it rests; see Figure 9. This is the administrative package of Edition I.

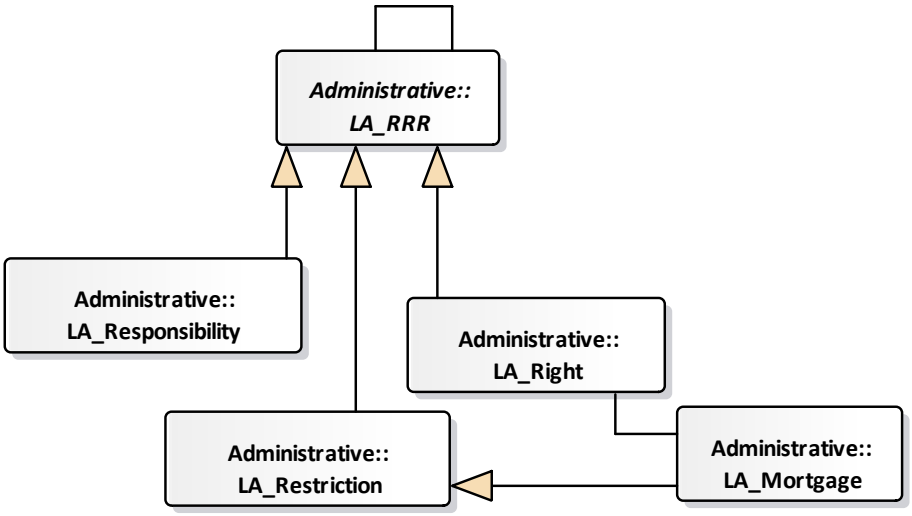

Figure 9. LA_Mortgage as part of the Administrative Package in Part 2 of Edition II: Land Registration

Spatial units, feature types related to land administration/ georegulation with associated spatial and thematic attributes, are refined into four specializations (see Figure 10) in the Spatial Unit package in Part 2:

- parcel; which concerns the legal space of a parcel;
- utility networks; which concerns the legal space, which does not necessarily coincide with the physical space of a utility network;
- building units; which concerns the legal space not the physical space of a building; and:
- infrastructure; which concerns the legal space not the physical space of an infrastructure.

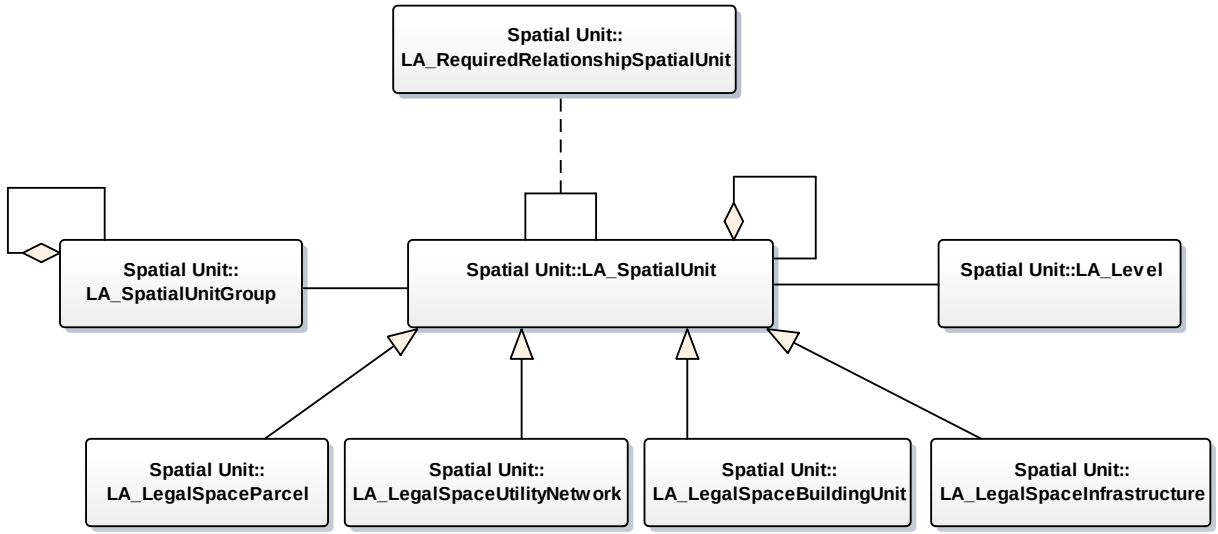

Figure 10. The four subclasses of LA_SpatialUnit in the Spatial Unit package in Part 2, Land Registration

The LA_SpatialSource class as defined in LADM Edition I, is proposed to be further developed, see Figure 11. There are two subclasses of LA_SpatialSource: LA_SurveySource and LA_DesignSource. A survey is documented with survey sources Sometimes, several documents are the result of a single survey. A design document (e.g., BIM/IFC, DXF) is documented with design sources. A spatial source (survey or design) may be official, or not (i.e., a registered survey plan, or an aerial photograph).

The subclasses of the LA_SurveySource relate to the various survey acquisition methods that can 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 and point-cloud observations.

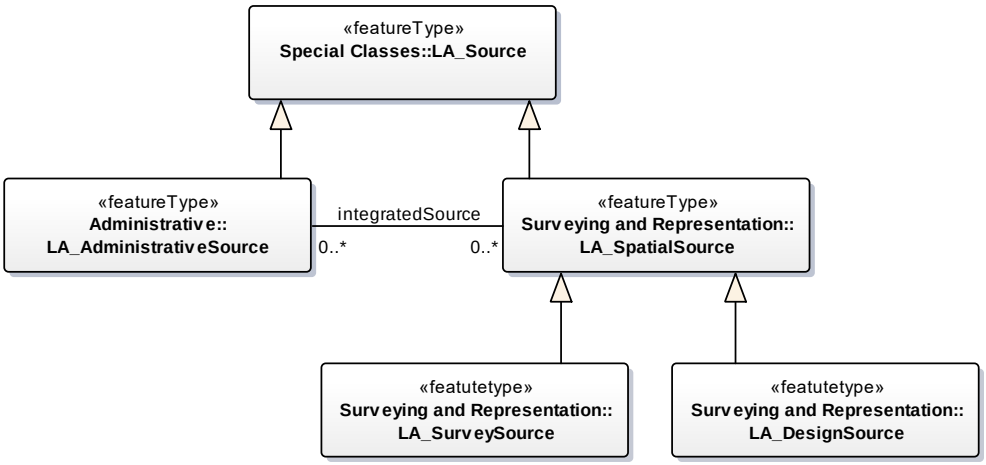

Figure 11. Class LA_Source, with subclasses

Coordinates themselves either come from points or are captured as linear geometry. Points, lines, surfaces and volumes can be acquired in the field (with classical topographic surveys, or with satellite navigation systems), in an office (reusing input from design), or compiled from various sources, for example using forms, field sketches or orthophotos. The acquisition of points, lines, surfaces or volumes (through a topographic survey) may concern the identification of spatial units on a photograph, on an image (orthophoto), or on a topographic map; while cycloramas or pictometry methods (multiple images from different angles) may also be used for that purpose. 2D and 3D representations of spatial units use boundary face strings as instances of class, and boundary faces as instances.

The individual points are associated to LA_SpatialSource. While it is not required that the complete spatial unit is represented, a spatial source may be associated to several points. Geodetic control points, including multiple sets of coordinates for points, and with multiple reference systems, are all supported in the LADM.

The survey model is refined (see Shnaidman et al., 2019 and Kalogianni et al. 2020c) with various measurement types based on the OGC's LandInfra/InfraGML standard (OGC, 2016).

Figure 12 also shows the global overview of the Surveying and Representation subpackage in Part 2.

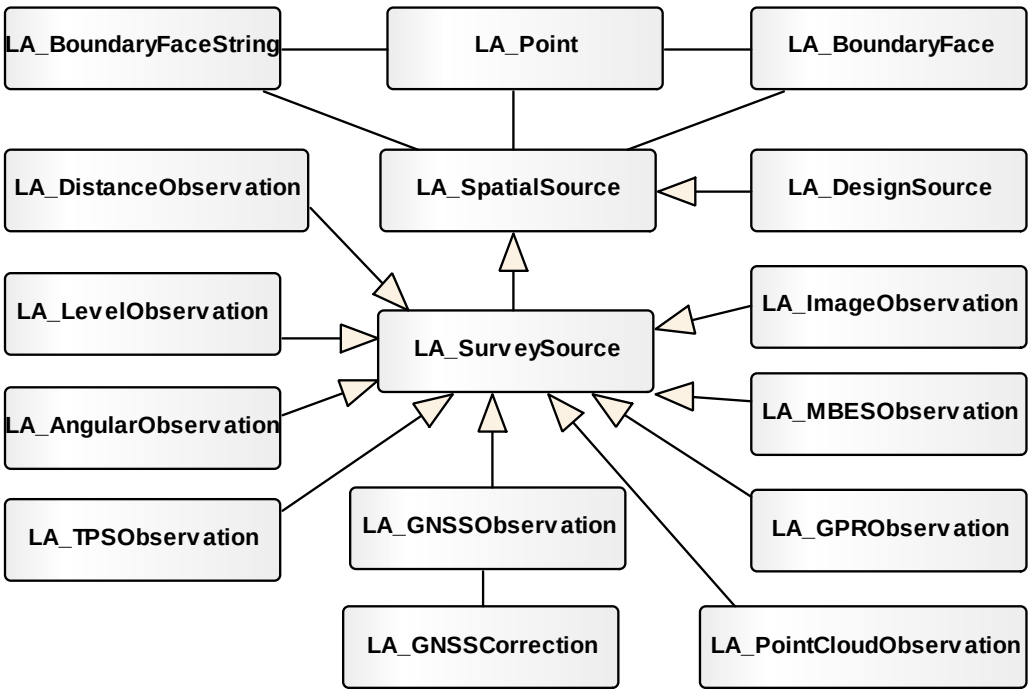

Figure 12. Surveying and Representation subpackage - new measurement types

Legal space is proposed to be linkable to physical objects in Edition II – by identifiers or re-use of descriptions of space. An IndoorGML-LADM model is one example of linking physical and legal objects one to another. In Part 2 of LADM Edition II, the combined use of IndoorGML and LADM is proposed to be used in order to define the accessibility of the indoor spaces based on the ownership and/or the functional right for use.

In LADM Edition I, the Spatial Unit Package and the Spatial Representation and Survey sub-package allows a set of possible representations of spatial units in 2D, 3D or mixed dimension (integrated 2D and 3D), ranging from "text based" spatial unit to the "topology based" level encoding, providing a framework for categorisation of spatial units. After an inventory study concerning the 3D aspects in the revision of LADM (Kalogianni et al., 2018), Part 2 of the LADM Edition II will include refined 3D spatial profiles to support the full lifecycle of 3D objects (see Thompson et al., 2015, 2016; FIG, 2018b; Kalogianni et al., 2020b).

Figure 13 shows how in 3D, a general boundary approach can be used by referring to ExtPhysicalBuildingUnit, which could be a BIM/IFC designed model of a building, see also Alattas et al. (2021, 2022).

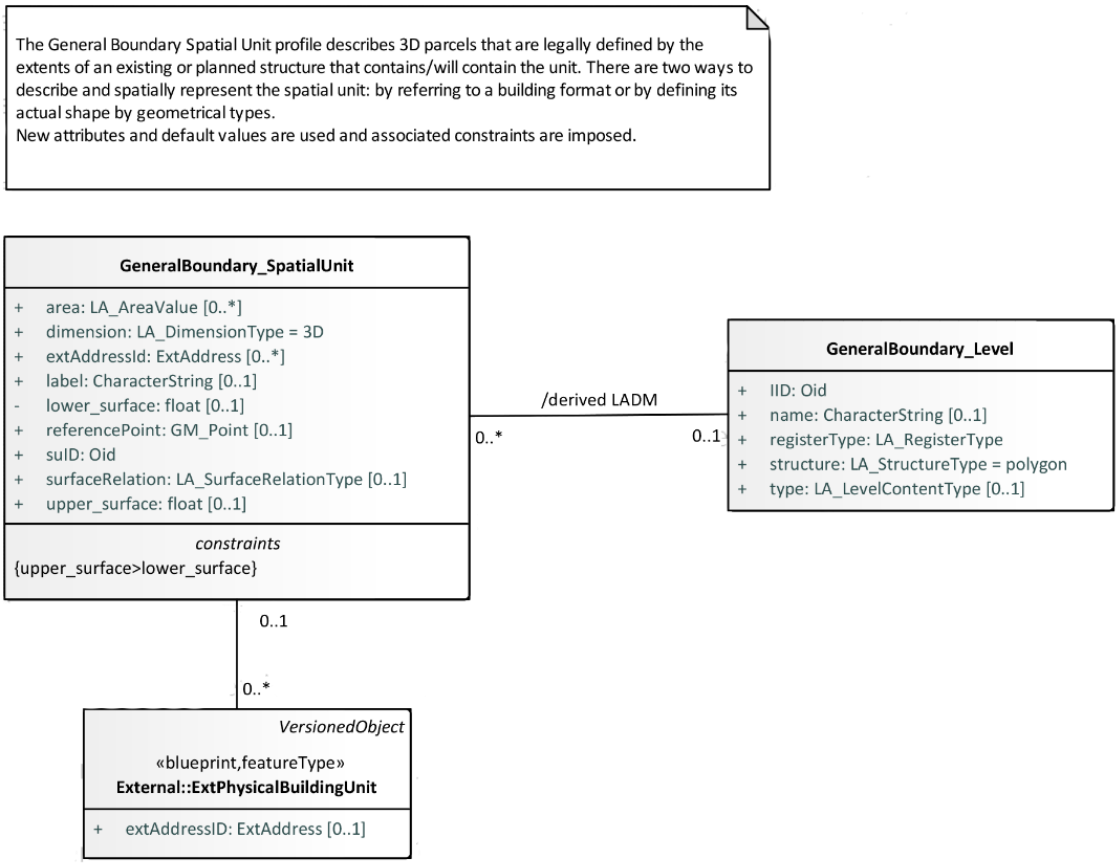

Figure 13. Proposed spatial profile for building/construction format spatial units (Kalogianni et al., 2018)

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.

Intense exploitation of land in the vertical direction has brought up complex legal relations between different types of spatial units with various characteristics (e.g., land, marine, air, underground parcels, and infrastructure objects). For this reason, the use of 3D models is not only required to clearly represent real property and associated rights but also 3D representations of restrictions and responsibilities, deriving both from Private and Public Law (Kitsakis, 2021 and Kalogianni et al., 2022). Moreover, LADM is designed to provide efficient support for the title and deed registration systems (as others e.g., in socialist environment), as well as a possibility on modelling restrictions and responsibilities as rights' relationships between an owning and a benefitting party (Kalogianni et al., 2022).

More attention is given to provide semantically enriched, structured (thesaurus/ontology) and versioned code lists in Part 2. Paasch et al. (2015) and Stubkjær et al. (2018) propose code lists as a mean of internationalisation by which the classes of the LADM may be related to a

particular jurisdiction. In this context, a metamodel is created to describe the necessary components for the design of code lists (see, Stubkjær et al., 2019; 2021; Kara et al., 2022).

5. LADM EDITION II PART 4 – VALUATION INFORMATION

The Valuation Information Package (VM) (Kara et al., 2018; 2020; 2021) specifies the characteristics and semantics of valuation registries maintained by public authorities. The main classes of the Valuation Information Package are VM_ValuationUnit, VM_ValuationUnitGroup, VM_SpatialUnit, VM_Building, VM_CondominiumUnit, VM_Valuation, VM_MassAppraisal VM_TransactionPrice, VM_SalesStatistic, and VM_ValuationSource, see Figure 14.

Valuation units are the basic recording units of valuation registries, and realized by an aggregation relationship of VM_ValuationUnit onto itself, see Figure 14. The object of valuation may be (a) only a land parcel, (b) only a building, (c) land parcel(s) with/without building(s) together as land property, (d) condominium unit consisting of building part(s) (e.g., condominium main part, condominium accessory part, joint access facility) and a share in land parcel(s).

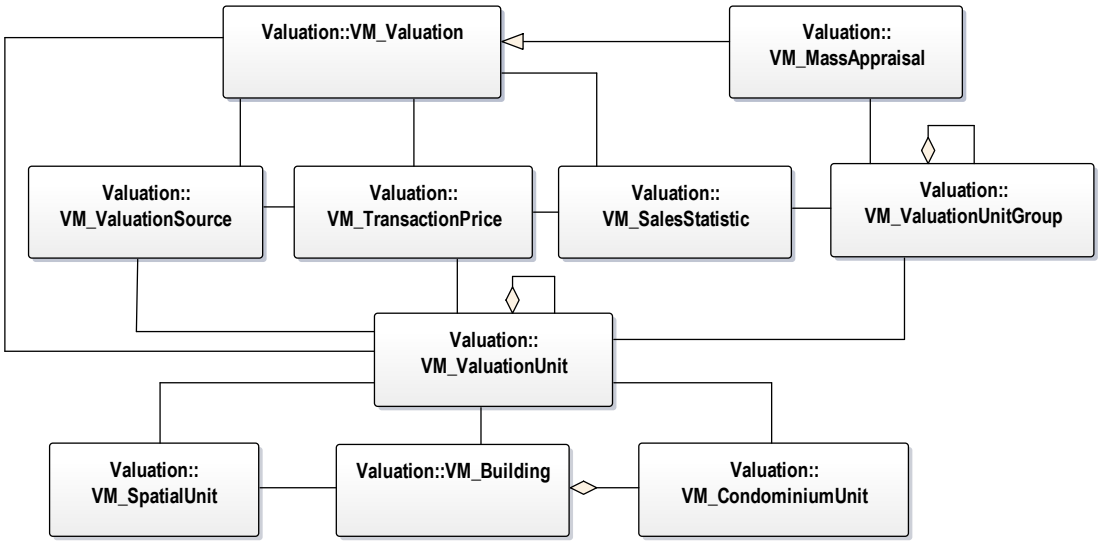

Figure 14. Classes of the Valuation Information Package, Kara et al. (2020; 2021)

Valuation Unit Groups, are realized by an aggregation relationship of VM_ValuationUnitGroup onto itself, see Figure 14. A valuation unit group may be a grouping of other valuation unit groups. Valuation units may be grouped according to zones (e.g., administrative divisions, market zones) that have similar environmental and economic characteristics, or functions of valuation units (e.g., commercial, residential, agricultural) that have similar characteristics.

The class VM_SpatialUnit represents land parcel(s) (e.g., cadastral parcel and/or sub-parcel) that are subject to valuation. The class VM_Building includes the building characteristics

required in valuation processes (e.g., date of construction, energy performance, use type). A building may be considered as a complementary part of parcel(s) (VM_SpatialUnit), but may be valued separately from the parcels on which it is located.

A building may represent a condominium building, which consists of (i) condominium units (e.g. apartments, shops); (ii) accessory parts assigned for exclusive use (e.g. garages, storage areas); (iii) and joint facilities covering parcel, structural components (e.g. foundations, roofs), accession areas (e.g. entrance halls, spaces), and other remaining areas of buildings (e.g. staircases, heating rooms) (see OGC's Land and Infrastructure Conceptual Model Standard). Condominium units are instances of class VM_CondominiumUnit. A condominium unit is for the exclusive use of the individual condominium owner and shares in a condominium building.

The class VM_Valuation specifies output data produced within valuation processes, especially for property tax assessment. It concerns date of valuation, value type, valuation approach, and assessed values of valuation units. The class VM_Valuation has mass appraisal class as specialization. Mass appraisal is a process of valuing a group of valuation units using standardized procedures at a given date. The class VM_MassAppraisal describes mathematical models, mass appraisal analysis types (e.g., multiple regression analysis), and the sample size of the analysis.

The class VM_TransactionPrice characterizes the information content of transaction contractor declarations, including the date of contract or declaration, transaction price, date and type of transaction (e.g., sale, heritage, forced sale, and rent prices).

The class VM_SalesStatistic has sales statistics as instances. It represents sales statistics produced through the analysis of transaction prices. VM_TransactionPrice and VM_SalesStatistic serve valuation activities for different requirements, e.g., estimating property values for property taxation, expropriations, and monitoring price trends.

In principle, property valuation is based on a valuation source (e.g., valuation report, sale contract, rental contract, declaration), as instances from the class LA_ValuationSource.

It is clear that valuation has many relationships with 3D representation, as height is a part of the property location. Height has big influence on view, and also some relation to other factors such as noise, safety and routing. It is therefore expected that LADM Valuation implementation will use the 3D possibilities of the LADM. Kara et al. (2020 and 2022) did develop an initial prototype with cases from Turkey and the Netherlands.

6. LADM EDITION II PART 5 – SPATIAL PLAN INFORMATION

The Spatial Plan (SP) Information Package (Indrajit, et al., 2020; Indrajit, 2021) includes planned land use (zoning) to be converted into rights, restrictions and responsibilities. This

package has five classes: (1) SP_PlanBlock, (2) SP_PlanUnit, (3) SP_PlanGroup, (4) SP_RequiredRelationshipPlanBlock and (5) RequiredRelationshipPlanUnit.

SP_PlanBlock contains a recommendation or a expected land use with deontic expressions (i.e. permissible-impermissible, obligatory-omissible, optional, and ought) for an activity or use or physical development imposed on a spatial unit accommodated in SP_PlanUnit. The SP_PlanUnit contains detailed prescriptions or specifications of an activity and physical development at spatial unit level.

SP_PlanBlock and SP_PlanUnit have an optional association class: SP_RequiredRelationshipPlanBlock and SP_RequiredRelationshipPlanUnit (see Figure 16). The required relationships are explicit spatial relationships between space in SP_PlanBlock and SP_PlanUnit with instances of class SP_RequiredRelationshipPlanBlock. The SP_RequiredRelationshipPlanBlock class facilitates declaration of explicit spatial relationships or criteria, such as to declare geometric quality of the zoning block or zoning unit or to declare topology relationships between zoning blocks and zoning units to spatial units. The class SP_PlanGroup is to accommodate hierarchy in spatial planning, such as: (a) regional-wide (e.g., European regions), (b) Country-wide (e.g., Indonesia, the Netherlands, so forth), (c) Island, (d) State or Province, (e) Municipality or City, and (f) Urban or Rural.

The Spatial Plan Information Package (Indrajit, et al., 2020) reuses LADM classes to represent spatial planning from the Party Package and the Administrative Package. This package models Parties involved in providing legal aspects (right, restriction and responsibilities) from spatial planning processes using classes and classes from LA Party.

SP_PlanUnit represents spaces of zoning plan and their characteristics in zoning plan activities. Each of zoning plan in SP_PlanUnit has specific RRRs derived from spatial planning processes. A land or space in zoning plan may share boundaries or not.

SP_PlanUnit registers a detailed spatial planning zoning unit or neighbourhood planning which contains right, restriction and responsibility. In principle, rights, restrictions and responsibilities derived from spatial planning processes are based on an administrative source.

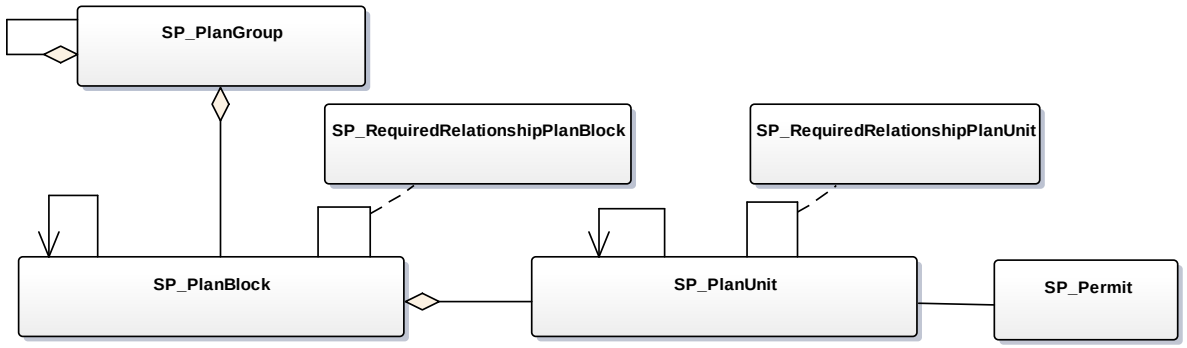

Figure 15. lasses of the Spatial Plan Information Package (Indrajit, et al., 2020)

The class SP_RequiredRelationshipPlanUnit on SP_PlanUnit allows for creating instances of relationships between spatial planning units. Relationships can be legal, temporal, or of a spatial nature.

The class SP_Permit contains permit related information as issued by authorities to parties fitting in the relevant plan unit.

Similar to the other part, there is a strong development that spatial plan information described more and more in 3D. Indarijt et al. (2021) developed a prototype for web-based dissemination system for 3D spatial plans in Indonesia for the cities of Jakarta and Bangung.

7. CURRENT STATUS OF LADM EDITION II

Effective and efficient system development and maintenance of flexible (generic) systems requires standardisation.

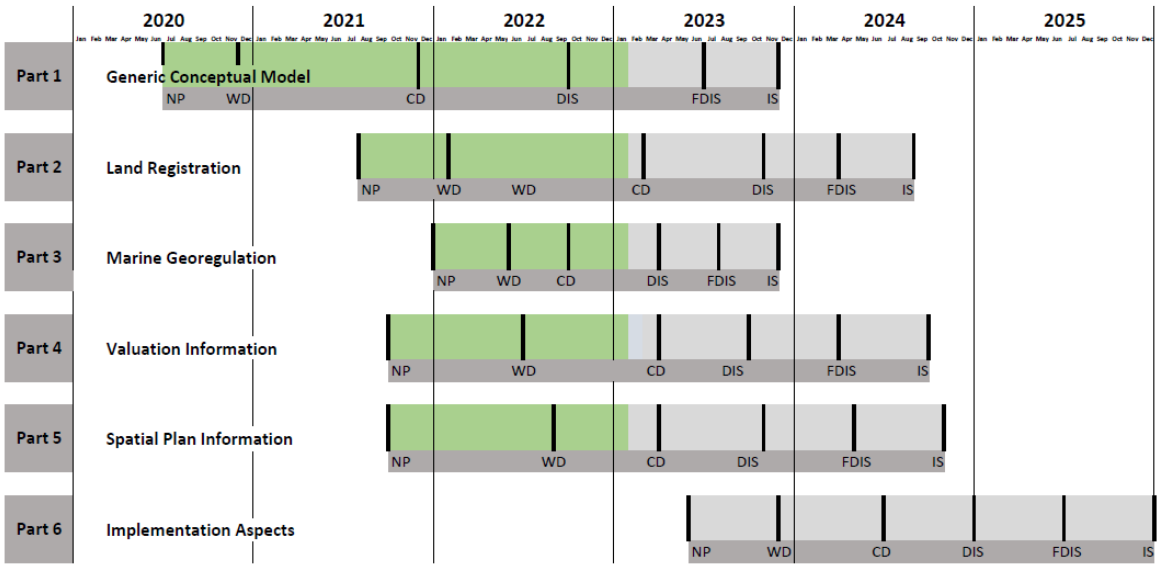

Figure 16. LADM Edition II – Current Status of All Parts of LADM as of February 2023

Following the publication of the LADM by the ISO in 2012, several proposals have been made to refine and extend the scope of LADM by LA community. The formal process of the ISO requires going through many stages in which the experts proposed by the member states to the relevant technical committee, ISO/TC 211 in LADM case, take part.

The NWIPs for the first five Parts of LADM Edition II are prepared by the editors. The package structure is designed by the editors. In addition, the editors also propose the contents of the packages, which are discussed in several ISO/TC 211 meetings. This approach actually demonstrates the ISO validation mechanism. This means that the structure, refinements and

new content proposed by the editors has been evaluated, commented on and improved by the LA experts.

Figure 16 shows the current status of all Parts of the LADM Edition II as of February 2023 and the expected dates of their publication.

8. CONCLUSIONS

This paper provides an overview of the structure of LADM Edition II and its capabilities in support to land administration. The six Parts of Edition II of the standard are briefly described, and their maturity on the ISO revision process is presented.

LADM Edition II adds capabilities to support marine space georegulation (not presented in this paper), valuation information, spatial plan information (supporting spatial development) and is closer to implementation (also technical models and processes). This makes LADM Edition II's coverage of land administration/ georegulation more complete, which is important if the aim is to harmonise models from these closely related LA (sub)domains. The (positive) votes received on the Parts during balloting in ISO may indicate that the international LA community is satisfied with the proposed refinements and developments.

Part 6 is planned to cover a methodology for developing an LADM country profile, an abstract framework for representing LA workflows (processes), a metamodel for structuring and managing semantically enriched code list values, and support for different encodings (e.g., GML, INTERLIS, RDF, GeoJSON, etc.). In addition, Part 6 is expected to include the OGC API family of standards-compliant recommendations for the development of interoperable LADM schema-based information systems. Furthermore, the relationships between the LADM and the instruction guidelines for property measurement, such as the International Property Measurement Standards (IPMS) and the International Land Measurement Standard (ILMS), is planned to be included in Part 6.

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