Towards LADM Victoria country profile – modelling the spatial information

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Key words: LADM, ePlan, Australia, Victoria, Cadastre, Vicmap

SUMMARY

Managing properties and people's interests in complex multi-level developments is rapidly increasing the last decade and as a result, current cadastral information systems are facing a growing demand to capture, register, maintain, visualise and disseminate 3D spatial information. This has led to a continuous research, at the international scenery, for 3D models and standardization initiatives that help communicate the legal and spatial notions of the built environment.

Each of Australia's states has already established a well-functioning Cadastral Information System, which are progressively moving towards 3D Cadastre. Alongside, the LADM ISO 19152 has gained ground and since its adoption as international standard there have been several attempts by different jurisdictions worldwide to adopt LADM. This however, does not apply for Australia, as only one country profile has been developed – for Queensland – back in 2012.

Considering that the LADM edition I revision has already started and through this process improvement and extensions of the current conceptual model, technical LADM specifications through application schemas and encodings, as well as process models will be discussed and investigated, it was a challenge to investigate the possibilities of adopting LADM in Victoria. Given this background, at this paper an approach to model the spatial counterpart of a future LADM-based profile for Victoria is presented, in the context of exploring the implementation issues of 3D Cadastre in Victoria, Australia using LADM. The current status of 2D and 3D cadastral developments in Victoria is presented and the direction towards the adoption of LADM in Victoria is introduced.

To be able to develop a LADM Victoria country profile, which will describe the existing situation, but at the same time will be future proof, as first step the mapping between the two existing data models and LADM classes is performed.

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1. INTRODUCTION

Land development processes, today, increasingly demand for the registration, visualisation and access to three-dimensional (3D) spatial information. Hence, at the international scenery there is a continuous research for 3D models and standardization initiatives that help communicate the legal and spatial notions of the built environment, as 2D maps can no longer provide comprehensive representations of the spatial dimension of the real world. In complex built environments, land administration practices refer to the information and processes required to support the capture, subdivision, registration and ongoing management of Rights, Restrictions and Responsibilities (RRRs) associated with vertically arranged private, common and public property units. These practices differ from one jurisdiction to another. In this context, the Land Administration Domain Model has been developed to provide an international framework for the most effective development of a 3D Cadastre.

Since the adoption of LADM in 2012 as an international standard (ISO 19152, 2012), there have been several attempts by different jurisdictions worldwide to adopt LADM, usually at the conceptual stage. Its flexibility and functionality have been tested through prototype implementations, while significant research has been carried out regarding its integration with other guidelines and focus was given on its technical implementation using geo-information standards and encoding formats such as: BIM/IFC, CityGML, LandXML or LandInfra, IndoorGML, etc.

LADM enables fit-for-purpose land administration and thus, various LADM-based country profiles have been developed the last six years and others are currently being developed; such as profiles for countries in Latin America (Colombia, Brazil), Asia (Turkey, Malaysia, South Korea, city of Shenzhen in China, etc.), Europe (The Netherlands, Croatia, Czech Republic, etc.), Russian Federation, Middle East (Israel, etc.) and Africa (Ethiopia, Nigeria, etc.). Given the plethora and diversity of those country profiles, it is noticed that there is no such LADM experience in Australia, where only one country profile has been developed for Queensland and this was included at the informative Annex D of ISO 19152 (ISO, 2012), which means that current knowledge has not been applied in Australian reality.

This can be supported by the fact that Australia has already established a well-functioning Cadastral Information System (CIS) in each one of its states and territories, and for such organisations, the adoption of the LADM is considered a major variation in the existing implemented system because it has not been identified as a critical public or stakeholder need. However, when maintaining such advance CISs, a routine upgrade that implements the LADM can be beneficial (Kalantari et al., 2015). Given its international character, LADM is subject to evolution and change and the more it is implemented, several areas for improvements and possible extensions are identified. Thus, new user requirements in the land

administration field emerge LADM revision aiming at sharpening and explicitly modelling the initial scope of the model. The revision of LADM started in May 2018 at TC211 meeting in Copenhagen.

Considering current LADM experience, its upcoming revision, as well as the established land administration system in Victoria the time seems to be mature for the development of the LADM Victoria country profile. As Victoria already has a well-functioning land information system and investigates the pathway and direction towards the implementation of a 3D digital cadastre, as a first step it is considered crucial to investigate the mapping between the LADM and the current digital cadastral protocol, ePlan. For the development of the LADM profile for Victoria the following steps should be realised:

- Analysis of the requirements defined in appropriate national law and other relevant regulations and documents;
- analysis of the current land information system in Victoria, its data dictionary and data sets;
- conceptual modelling to capture concepts in the cadastral domain;
- development of a standardized domain model based on LADM and adapted to Victoria's local conditions;
- creation of instance level diagrams with real-world use cases to test the proposed model;
- testing the conformity of the proposed country profile with ISO 19152.

Given this background, at this paper an approach to model the spatial counterpart of a future LADM-based profile for Victoria is presented, in the context of exploring the implementation issues of 3D Cadastre in Victoria, Australia using LADM.

The rest of the paper is structured as follows: Section 2 presents the current status of 2D and 3D cadastral developments in Victoria. In Section 3, the direction towards the adoption of LADM in Victoria is presented, including the mapping of LADM classes with ePlan concepts, the modelling of spatial information in ePlan and LADM, as well as the foundations for the proposed spatial counterpart of the future LADM-based country profiles. Following, the last Section is devoted to the conclusions of this research and the future work, introducing the opportunities of developing the Victoria LADM profile during the revision of LADM.

2. CURRENT DEVELOPMENT OF 2D AND 3D CADASTRAL REGISTRATION IN VICTORIA

The current land administration system of Victoria operates on a title-based system of land registration. In Victoria, it is possible to secure ownership of land and spaces above and below it. Whether on the surface or above or below the land, there is a single process to issue a certificate of title. As such, there is no distinction between 2D and 3D cadastres in Victoria. Having said that, the distinction can be made, on the details of 2D or 3D data. Historically, in Victoria, the land is subdivided using cadastral plans. If a subdivision only involves land and not spaces above or below land the data in the plans only includes the dimensions of land subdivided and the underlying survey work. If a subdivision involves spaces above or below

the land then in addition to the data in the land subdivision there is also data about ownership boundaries defined and guided using building structures or textual notation. Information about the land subdivisions is extracted and used to compile and update the Digital Cadastral Database (DCDB) of Victoria. This information is limited to the approximate dimensions of land and does not include underlying survey data and ownership boundaries defined by building structures or textual notations.

The DCDB is maintained in a database called Vicmap property. Since 2012, Victoria has introduced a system that is called ePlan which aims to replace the paper-based cadastral plans with a digital data based on LandXML; an internationally recognised format for engineering and survey information. It is noted that in Victoria, the definition of legal interests and legal boundaries is not only predicated on cognitive elements, but physically existent objects also play a significant role in communicating and managing the spatial locations of legal arrangements. In the next sections, Vicmap property and ePlan will be discussed.

2.1 Vicmap Property

Cadastral records have been historically developed and evolved to facilitate land administration systems. A cadastre typically records the spatial extent of Rights, Restrictions and Responsibilities (RRRs) on land. The cadastre is used in land transfers and developments to ensure the existing RRRs are protected and newly created RRRs are appropriately defined and recorded. Cadastral records in Victoria include dimensions of land titles and associated field measurements and notes undertaken as part of cadastral surveying. The records also include restrictions on land, some of which defined spatially. The records are locally defined in relation to monuments. The recent records are connected to a defined datum.

The cadastral records are organised using survey plans. There are different types of plans in Victoria including Parish, Lodged, Title and Subdivision each created under different Acts governing land administration in different periods of the history of Victoria. While all of plan types are available in an image format, the content of the plans varies concerning the requirement of this tender.

Vicmap Property is a representation of the cadastre in Victoria. In the early 90s, Vicmap Property was compiled by digitising various sources including property maps maintained by utility companies, local governments and cadastral plans. The current DCDB is maintained and kept up-to-date using plans of subdivision. Vicmap Property provides information about land parcels and property details (Figure 1). The database is continuously maintained, obtaining maintenance information from new land subdivisions. The data model of Vicmap property includes parcel (ownership extent) and property (rateable land) polygons in metropolitan areas and parcel polygons in rural areas. other types of interests such as easements or restriction that are available in survey/subdivision plans are not available in Vicmap property. There is limited information about ownership below and above land in Vicmap property which is provided at attributes assign to polygon organised in different layers. The Vicmap Property is indeed a limited 2D representation of the cadastre in Victoria. While it is an authoritative source of property data in Victoria it not a survey-accurate spatial data.

For various reasons, in the compilation and maintenance of Vicmap Property, the title dimensions, field measurements and notes available in cadastral records are not used. As such the DCDB is not regarded as spatially accurate and this is acknowledged by the surveying and spatial industries. Regardless, Vicmap Property is widely used in other public domains including urban planning, infrastructure engineering, public safety, disaster management. The general public and private sector also utilise Vicmap Property, however, most of the users are not aware of the accuracy implications of the current Vicmap Property. A potential approach to improve the accuracy of Vicmap Property is to incorporate the relevant content of the existing cadastral plans including dimensions, notes and measurements; an approached that the ePlan initiatives has taken in Victoria.

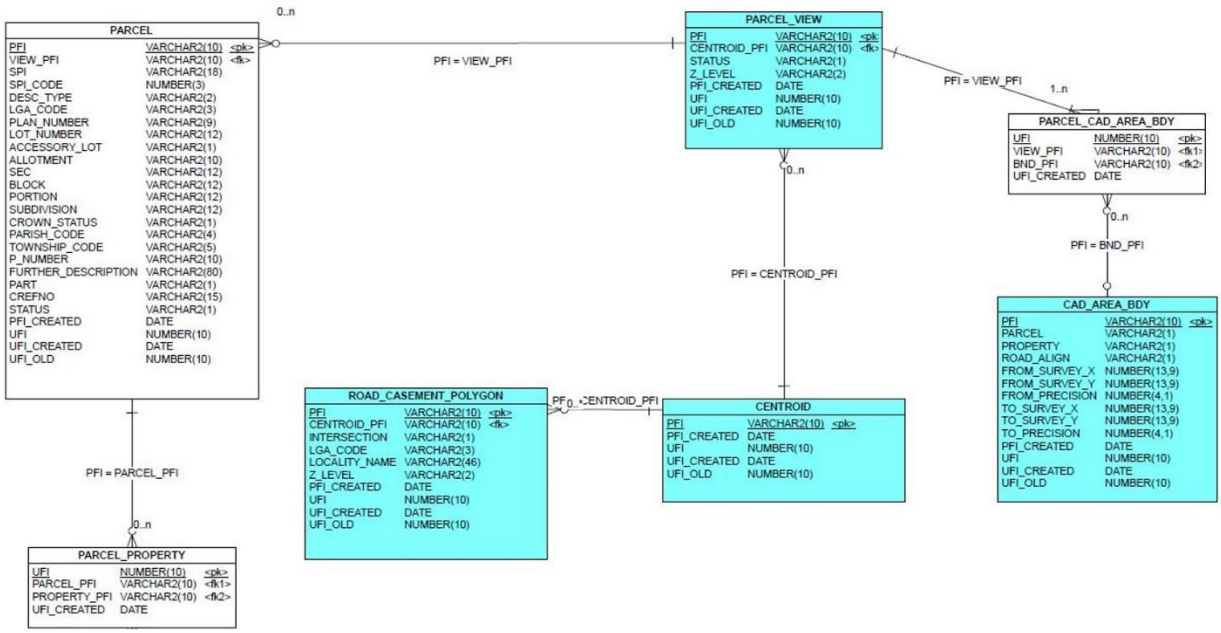

Figure 1. Excerpt of Vicmap property standard data model (Victoria State Government, 2018)

2.2 ePlan

ePlan is a data model of the cadastral survey in all jurisdictions in Australia. Initiated in 2003, it aims to replace paper-based cadastral with digital data using LandXML as the underlying data format. ePlan includes data on surveying measurements; land parcel description and identifiers; dimensions of the parcel and RRRs on land such as easements; administrative information on the subdivision; annotations; plan approval status, the surveyors' details and so on. It is developed using UML class diagrams and implemented using LandXML and its various schemas and protocols. As the LandXML format is used to exchange information about civil infrastructure and surveying data, it has a wide schema covering various components. For cadastral purposes in the context of ePlan a subset of LandXML schema is used.

One of the ePlan advantages is that information in ePlan files can be extracted, populated into Vicmap Property and reused for the creation of new subdivision plans. The digital data extraction can contribute to improving the accuracy of Vicmap Property. The digital data can

also facilitate the automatic validation of cadastral plans concerning surveying errors; mathematical closure of parcels; and content and compliance with the regulatory requirements.

ePlan has been operational in Victoria since 2008. There are several ePlan tools that are available in Victoria. The surveyors can prepare ePlan files using specific software solutions (e.g. LisCAD), they can lodge ePlan files using an online portal called SPEAR. The ePlan files can automatically be visualised in conventional plan formats and they can be automatically validated against the regulatory requirements. Currently, ePlan is mainly used for simpler land subdivisions but increasingly more complex land subdivisions are being prepared based on ePlan. However, currently, ePlan does not support the subdivisions of the space above and below land which is a work in progress in Victoria concerning modelling, visualisation, validation and integration into the database.

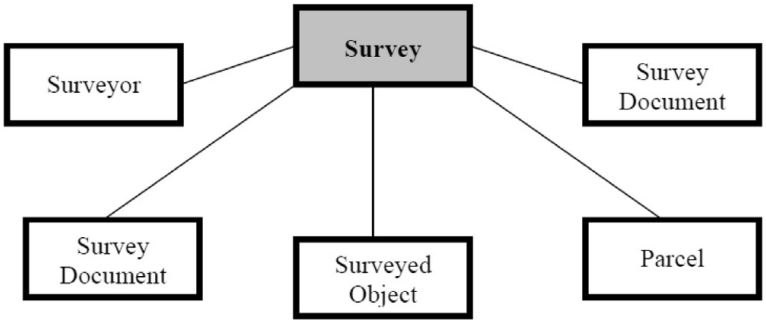

Figure 2. Overview of the ePlan data model diagram (Karki et al., 2011)

3. ADOPTING LADM IN VICTORIA, AUSTRALIA

In order to adopt LADM in Victoria, it is important to consider several factors as suggested by Kalantari et al. (2015). It can be observed that there is no legal mandate or demand by stakeholders yet for the adoption of the standard, however, as Victoria is in the process of digital cadastral modernisation and developing its 3D digital cadastres there might be an opportunity to consider the LADM compliance cadastral information system. In adopting LADM, Victoria will need to involve a wide range of stakeholders and review numerous legislation needs to meet the requirements of the stakeholders. Victoria, an individual state, is a small market for the cadastral software solution and this potentially makes the software vendors reluctant to adopt the LADM. In the long term, it is needed to introduce LADM in relevant tertiary education systems of Victoria together with refreshers course for the stakeholders.

To investigate the opportunities of adopting LADM in Victoria, a thorough review is required to map LADM and ePlan data models which is an intermediate step for mapping LADM to Vicmap property. Having said that a crosswalk between the ePlan data model and LADM demonstrates some degree of compatibility. In this Section, at the beginning, a better understanding to ePlan usage is presented, in order to be able to match its elements with LADM core classes. Following, the matching between LADM and ePlan classes is presented,

the modelling of spatial information in the two systems is introduced and finally, the foundations for modelling the SpatialUnit Package for the future LADM Victoria profile are presented.

3.1 Analysing ePlan

An approach to the understanding ePlan data model is to analyse the implementation of ePlan in LandXML. As it is illustrated in Figure 3, the information in ePlan files is organised in 8 classes of data. The classes include: Units of measurement, Application (software) that creates ePlan, Coordinate system, ePlan protocol that defines the structural and content integrity, CgPoints that contain coordinates of the points that are parts of survey measurements, Parcels and any other spatial object in the files, Parcels as the fundamental spatial unit for recording RRRs, Survey data which include field measurements recorded and Cadastral monuments that are used for referencing and re-establishing survey. The Protocol components are defined at the national and jurisdictional level and each jurisdiction provides a specialised version of the ePlan Protocol Schema specific to their jurisdictional requirements. Victoria has a jurisdictional enumerations schema to go with the Victorian ePlan Protocol schema.

Figure 3. Structure of an ePlan compliant LandXML file

To create a country profile in ePlan, it is important to note how the values are enumerated in ePlan structure to support different regulations in each jurisdiction. For example, as illustrated in Figure 4, there are different parcel constructs, types, classes and in Victoria. The parcel construct type, e.g. single, multipart, part, administrative. The state of the parcel in the context of other parcels on the plan, e.g. affected, created, extinguished. The type of registrable interest this parcel represents, e.g. Lot, Stage Lot, Common Property, Road, Easement.

state	lxml enum	R	The state of the parcel in the context of other parcels on the plan, eg `affected, created, extinguished`.
class	vic enum	R	The type of registrable interest this parcel represents, eg `Lot, Stage Lot, Common Property, Road, Easement`.
useOfParcel	vic ref	CR	Where further information is required to define the use of a parcel, eg various easement purposes, and `Limited/Limited to CP/Unlimited` for Owners Corporation Parcels.
parcelFormat	vic ref	O	The type of boundaries the parcel is described by, eg `Geometry, Standard, 2D Building`.

Figure 4. Parcel enumerations in Victoria (Victorian ePlan Protocol)

3.2 Mapping of core LADM classes and classes from Victoria Land Administration System

To be able to develop a LADM-based Victoria country profile, which will describe the existing situation, but at the same time will be future proof, as first step the mapping between the two existing data models and LADM classes should be performed, following the mapping that has been introduced by Kalantari et al., (2015).

There are some core conclusions that were identified during the mapping of core LADM classes with the ePlan classes. To name the core ones:

- ePlan is focusing on the surveying information, while LADM more on the administrative information;
- LADM covers a broader scope as an international standard for land administration and ePlan can be considered as a subset of ePlan;
- There are similarities in the both models, where each has a spatial component and an ownership, tenures component;
- The Parcel class in ePlan corresponds to both BAUnit and LA_SpatialUnit in LADM, suggesting the Parcel in ePlan models more cadastral data elements;
- LADM supports different types of spatial units such as utility networks and provides a number of spatial representations such as: sketch-based, text-based, point-based, line-based and topology-based, while ePlan supports only BuildingFormatLot and VolumetricLot spatial units;
- There are differences identified in the way ePlan handles RRRs and liabilities and entitlements of the parties;
- There is no class for handling RRRs as a separate entity from Parcels in ePlan structure. The RRRs area is totally contained in the Parcel element;
- Both models support temporal aspects;
- Physical objects cannot be modelled through ePlan as it does not provide any external linkage between legal spaces and their physical counterparts, while LADM supports the link with physical objects through external classes;
- The ePlan model development preceded the development of the LADM and has been adapted to Australian conditions, leading to significant differences in semantics and data structure, while it has significant overlap with the LADM (Karki et al., 2013).

The core LADM classes are matched in some cases with more than one classes and packages of the Victorian ePlan Protocol, as presented below.

Table 1. Mapping of LADM classes with Victorian ePlan Protocol packages, classes and elements

LADM	ePlan
PARTY PACKAGE	
LA_Party Parties that are involved in land transitions mainly in transferring RRRs	**Survey Package: SurveyHeader**
	Survey Package: SurveyHeader Personnel
ADMINISTRATIVE PACKAGE	
LA_ RRR RRR are described, and the shares of each party are defined	*There is no direct association - Concepts from the two elements below may be used:* **Parcel Package: Parcel: Title** **Parcel Package: Parcel class: Owner**
LA_BAUnit Represents administrative entities consisting of 0 or more spatial units against which 1 or more unique & homogenous RRR is associated	**Parcel Package: Parcel**
LA_AdministrativeSource Basic building block to describe a spatial dimension (textual, sketch, or point, linear, polygon & topology based).	**Survey Package: SurveyHeader: Surveyor Certificate**
	Survey Package: SurveyHeader: PurposeOfSurvey
	Parcel Package: Parcel: Title
	Survey Package: SurveyHeader: HeadofPower
SPATIAL UNIT PACKAGE	
LA_SpatialUnit Basic building block to describe a spatial dimension (textual, sketch, or point, linear, polygon & topology based).	**Parcel Package: Parcel: Parcels**
	Parcel package: PlanFeatures: PlanFeature
	Parcel Package: Parcel: VolumeGeom
LA_SpatialSource Includes surveying measurements with field observation	**Survey: ObservationGroup: RedHorizontalPosition** **&** **Survey: ObservationGroup: RedVerticalPosition**

LADM	ePlan
SURVEYING AND REPRESENTATION SUB- PACKAGE	
LA_Point Basic building block to describe a spatial dimension (textual, sketch, or point, linear, polygon & topology based).	**CgPoints:CgPoint**
LA_BoundaryFaceString	**Parcel Package: Parcel: CoordGeom: Line**
	Parcel Package: Parcel: CoordGeom: Irregular Line
	Parcel Package: Parcel: CoordGeom: Curve
LA_BoundaryFace	**Polygon class**
	Volume geometry
EXTERNAL CLASSES	
LA_ExtAddress Basic building block to describe a spatial dimension (textual, sketch, or point, linear, polygon & topology based).	**Parcel Package: Parcel: Location Address**

3.3 Spatial information modelling in ePlan and LADM

The focus of this paper is given on the modelling of spatial information of a future LADM-based profile for Victoria, in the context of exploring the implementation issues of 3D Cadastre. The Spatial Unit package of LADM is used for modelling the spatial dimensions of legal objects. An instance of "LA_SpatialUnit" class is used for modelling each individual 3D legal space or 2D land parcel (ISO19152, 2012). The Surveying and Representation sub-package is mainly used to model the topology of boundaries that define the spatial units.

Two subclasses of "LA_SpatialUnit" class, the "LA_LegalSpaceBuildingUnit" and the "LA_LegalSpaceUtilityNetwork" are used for modelling 3D legal spaces associated with buildings and utility networks, respectively. LADM provides enables the link between legal objects and their physical counterparts through the definition of external associations (external classes). At the current edition of the model, only the "LA_LegalSpaceBuildingUnit" class for building units and the "LA_LegalSpaceUtilityNetwork" class for utility networks are defined to link legal spaces of building units and utility networks to their physical counterparts, respectively (ISO19152 2012).

The fundamental entity "LA_SpatialUnit" includes various representations of ownership interests defined inside any jurisdiction providing six spatial profiles: "2D point based", "2D Text based, "2D Unstructured line based", "2D Polygon based", "2D Topological based" and "3D Topological based (Annex E, ISO 19152, 2012).

The "LA_BoundaryFace" class of the Spatial Representation and Survey sub-package defines the surface geometry of legal boundaries through its association with the "LA_Point" and "LA_SpatialSource" classes. A surface boundary must be defined by at least three points (Lemmen, 2010), while curve boundaries must be defined by at least two points since start and end points of a curve is required in the simplest case. The "geometry" attribute of "LA_BoundaryFace" refers to "GM_MultiSurface" to represent the geometry of the boundary surface in 3D. "LA_SpatialSource" provides information about a set of observations and measurements associated with points. These measurements may include distances, azimuths, GPS coordinates, etc.

On the other hand, in the ePlan model each individual 2D and 3D legal space is defined through "Parcel" class and specifically through the "CoordGeom" and "VolumeGeom" elements which are composed by several primitive objects, such as lines, curves and irregular lines. The "Parcel" class in the ePlan model is used for managing semantic and spatial information for legal interests and is responsible for defining different types of spatial units such as lots, stage lots, easements, common properties, roads and reserves. A boundary of a volumetric legal object is geometrically defined by its faces. Faces in ePlan are defined by CoordGeom element and six CoordGeom elements create a cube in 3D.

For storing the geometry of objects in the Victorian ePlan Protocol the following classes are used:"CgPoints" class includes attributes and position which can be both 2D or 3D; "Parcels" class include "CoorGeom" which represents the boundary of parcels that can be defined by lines, irregular lines and curves and "VolumeGeom" which represents volumetric parcels as defined by their faces; "Surfaces" for the Digital Terrain Models and "PlanFeatures" for generic geometric data like fence lines, as-built data (curbs, building outlines, etc.).

Shojaei et al. (2016) presented that ePlan can adequately support the geometry of legal boundaries; however, various legal boundary types defined in multi-owned properties cannot be semantically differentiated in this model.

3.4 Modelling the spatial counterpart of future LADM Victoria profile

At the following paragraphs an overview of the spatial component of the future LADB-based country profile for Victoria is presented as a first step towards the modelling of country's profile. The core of the Victoria LADM profile will consist of the four fundamental classes derived from the basic classes of the LADM (i.e. LA_Party, LA_RRR, LA_BAUnit and LA_SpatialUnit), using the prefix "VC" (Figure 5).

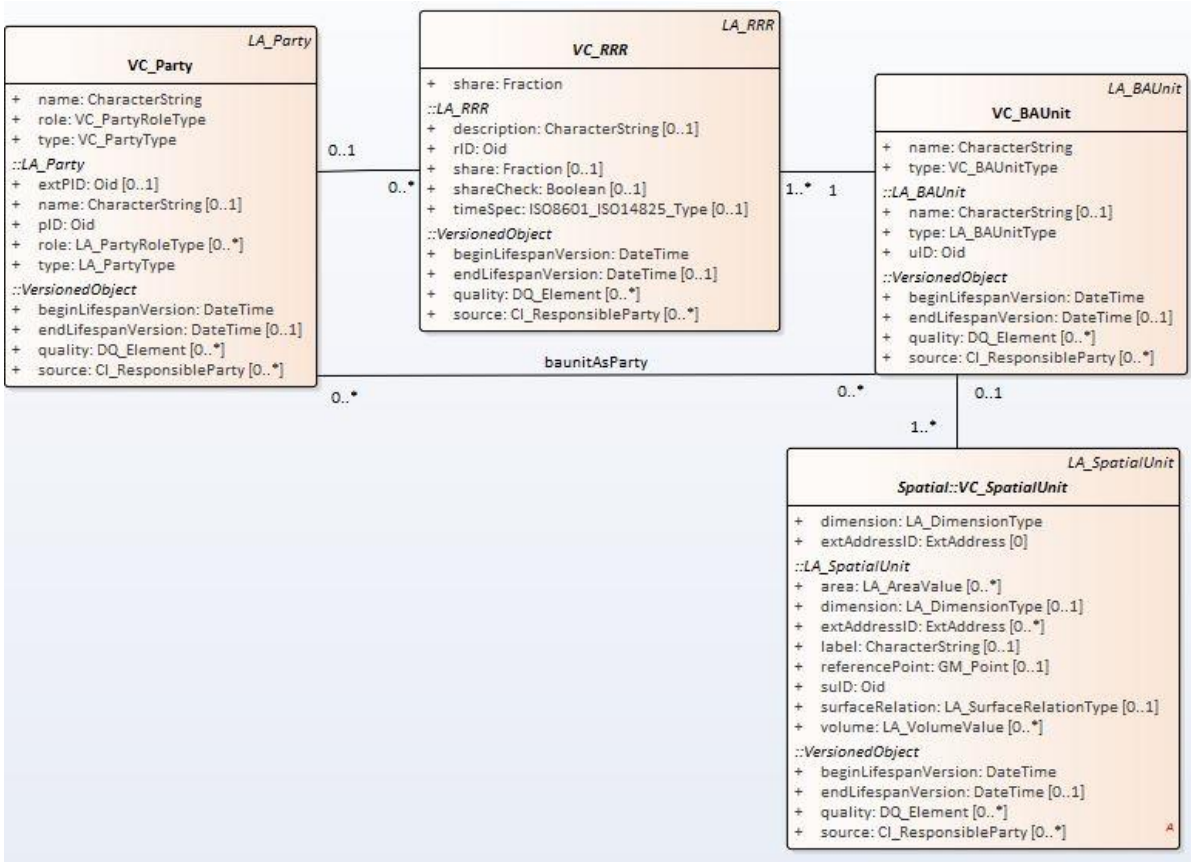

Figure 55. The four fundamental classes of the Victoria LADM-based country profile

For the spatial data modelling part of the model, the Class VC_SpatialUnit (with LA_SpatialUnit as a superclass) is created and is the fundamental entity of spatial data modelling of future LADM Victoria profile. Spatial units are modelled using the VC_SpatialUnit class and its three subclasses: VC_Parcel, VC_LegalSpaceBuildingUnits and VC_Building. As a next step, the creation of new classes representing the different types of spatial units will be investigated, as well as the modelling of new subclasses if and where needed. Corresponding code lists will be created according to the requirements of Victoria's legislation and regulations, using existing values from the existing Victorian ePlan Protocol.

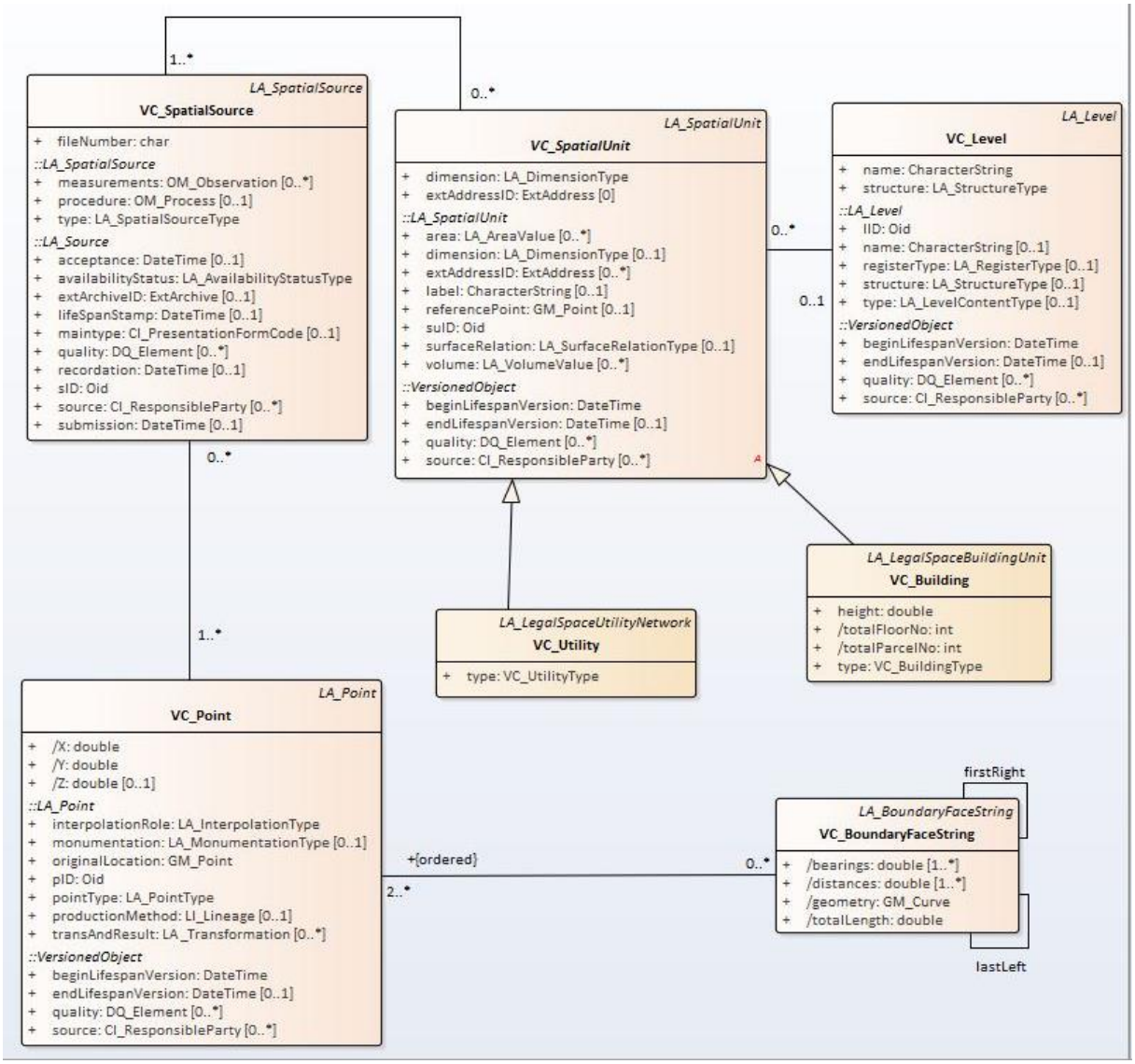

Figure 6. Overview of the spatial component of the future LADM-based country profile for Victoria

4. DISCUSSION AND CONCLUSIONS

Australia has already established a well-functioning Cadastral Information System and relevant authorities for its operation and maintenance, in each one of its states. For such organisations, the adoption of the LADM is considered a major variation in the existing implemented system because it has not been identified as a critical public or stakeholder need. However, talking about Victoria, which is on the way of digital cadastral modernisation and development of its 3D digital cadastre, there might be an opportunity to consider the LADM compliance cadastral information system.

Alongside, the LADM ISO 19152 edition I revision has already started, and through this process improvement and extensions of the current conceptual model, implementation efforts

towards the technical specification through application schemas and encodings, as well as process models will be discussed and investigated in order to be included at the edition II of the standard. At this paper the foundations for creating an LADM-based country profile for Victoria are presented. It is underlined that in adopting LADM, Victoria will need to involve a wide range of stakeholders and review numerous requirements of the stakeholders, will a broad range of database system requires a careful consideration in adopting the LADM.

To investigate the opportunities of adopting LADM in Victoria, current status of cadastral development in the state are presented, followed by a crosswalk between the ePlan data model and LADM, which is an intermediate step for mapping LADM to Vicmap property. Moreover, current spatial modelling opportunities through LADM and ePlan are presented to provide a better insight for the modelling of the spatial part of the future country profile. Lastly, an overview of the spatial unit part of the model is preseted as a first step towards the creation of the Victoria LADM-based country profile.

As a next step, both the non-spatial and spatial components of the country profile will be designed based on the assumptions presented in current research. Code lists of the proposed classes will be created serving the requirements of Victoria's legislative framework and other regulations. Additionally, the conformity of the proposed country profile with ISO 19152 will be tested.

From a 3D perspective, currently, ePlan does not formally support the registration of 3D spatial units and stratified interests are represented as 2D parcels. Volumetric lots and elements are not formally supported, as also mentioned in previous research (Aien, 2013; Shojaei et al., 2016) and the current structure of the model presents various options to fulfil the requirements of 3D Cadastre. From the mapping of the ePlan elements with the corresponding classes of LADM, it is clear that the 3D aspect may be supported in the future. In this regard and in the context of LADM revision, where one of the goals is to improve current 3D support of the standard, it is beneficial to develop a profile for Victoria focusing on the 3D aspect and testing the new 3D functionalities that will result from the revision.
What is more, a thorough review is required to examine similar concepts that are termed differently in the two models.

Last but not least, the ePlan model accommodates all of the survey geometry and administrative and titling data required to process a plan of subdivision from its initial preparation by the surveyor through to its lodgement with council for certification and subsequent registration (Kalantari et al., 2009). At the new edition of LADM workflow and process models will be created and it is considered that the ePlan process can be included and/or affect the creation of those models.

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