Towards Malaysian LADM Country Profile for 2D and 3D Cadastral Registration System

Nur Amalina ZULKIFLI, Alias ABDUL RAHMAN, Hasan JAMIL, TENG Chee Hua, TAN Liat Choon, LOOI Kam Seng, CHAN Keat Lim, Malaysia and Peter VAN OOSTEROM, The Netherlands

Key words: LADM, country profile, 2D and 3D cadastre, registration system

SUMMARY

This paper proposes a comprehensive Land Administration Domain Model (LADM, ISO 2012) country profile for 2D and 3D cadastral registration system for Malaysia. The proposed Malaysian country profile is partly based on the existing spatial (including survey) and administrative registration systems, and partly based on new developments inspired by the LADM standard. Within the country profile, an attempt is made to cover all Malaysian land administration related information, which are maintained by different organisations. The different types of spatial units include customary areas, reserved lands (forest, wildlife), lots (both of private and public land; e.g. roads), buildings and building parts (strata, all in 3D), strata land parcel (with house no more than 4 storeys) and utilities (legal spaces). The lots can have 2D or 3D representations, this include lots for qualified title and temporary occupation licence (TOL), where there is not yet a certified plan available. What makes the development of the Malaysian country profile unique is the support for a wide range of spatial units. Each of them having different requirements: some need sketches and text descriptions, others need 2D geometry and topology, while yet others need 3D geometry. The country profile includes the content of the various code lists, which are an important aspect of standardization. It is the first time ever that objects related to strata titles are modelled within LADM: building and land parcel (both within a single lot), which can be refined with parcel unit, accessory unit, and (limited) common property unit including support for provisional and multilayer/underground aspects. This is not only important for Malaysia, but also useful for many other countries, that also have the strata title system.

Several novel aspects for the Malaysian land administration are introduced, such as: 3D representations (for building units and option for lots), full version management and inclusion of historic information, explicit linking of all land administration information and source documents (titles, certified plans), possibility to group multiple spatial units in one basic administrative unit with same rights attached, and legal spaces around utilities (in 3D). The country profile helps to establish the national SDI enabling meaningful exchange of information between different (type of) organizations in different parts (states) of the country. As LADM is an international standard it will also support international exchange of information, as part of Global SDI (GSDI).

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1. INTRODUCTION

Land is a source of wealth and has continued to be the cause of social, ethnic, cultural and religious conflict from time immemorial. Thus, an effective land administration system is needed in order to meet the changing needs of the world societies. A good land registration system is pertinent to ensure protection of property rights. As society progressed and become more complex, so are the technology and innovations, which if correctly designed and applied, can significantly improve the business process in land administration system.

Nowadays, most countries have developed their own land administration system. Some countries operate deeds registration, other title registration. Some systems are centralized, and others decentralized. Some systems are based on general boundaries approach, others on fixed boundaries. Some systems have a fiscal background, others a legal one (Bogaerts and Zevenbergen, 2001). LADM was introduced as a model to create standardized information services in an international context, where land administration domain semantics have to be shared between regions, or countries, in order to enable necessary translations (ISO, 2012).

The Malaysian land administration system is based on the Torrens system. The Torrens title system was first introduced in South Australia in 1858 and subsequently used in other Australian states and some parts around the world. The main objective of the Torrens title system is to make the register of documents of title conclusive evidence of land ownership. Once a person's title or interest is registered in accordance with the prescribed registration procedures, it will be recorded in the register document of title, and the person in whose favour the dealing is registered will become the indefeasible proprietor or interest holder to the exclusion of all others.

Several earlier papers have discussed potential 3D extension and LADM conformance of Malaysian land administration (Abdul Rahman et al, 2011, Tan and Looi, 2013, Zulkifli et al, 2013). This paper continues from the earlier work and is organized as follows. Section 2 introduces the current land administration in Malaysia. Motivation for introducing LADM is described in Section 3. Spatial and administrative (legal) modelling of the Malaysian LADM country profile is discussed in Section 4. Conclusions and future work are given in Section 5.

2. MALAYSIAN LAND ADMINISTRATION

In Malaysia, there are two organizations responsible for managing and maintaining the cadastral system: Department General of Lands and Mines and Department of Survey and Mapping (both within the Ministry of Natural Resources and Environment); see Figure 1. The Department of Survey and Mapping Malaysia (DSMM or JUPEM in Malay) deals with the cadastral survey with high accuracy survey to determine the location, dimension and size of the properties. The Cadastral Survey System of DSMM is responsible for preparing, producing and managing the spatial component including the surveying and mapping of the cadastre parcels. The Land Registration System, which concerns the administrative (legal) data, is the responsibility of the Land Offices (or PTG, which stands for 'Pejabat Tanah & Galian' in Malay). The Land Office deals with ownership registration, i.e. who owns what the RRRs (Right, Responsible, Restriction). Both organizations have their own systems: eLand in Land Office and eKadaster in DSMM (Tan and Looi, 2013). These are two independent systems and still 2D in nature. The Unique Parcel Identifier (UPI) was introduced to link the Land Office and DSMM where every cadastral object has a unique identity number to differentiate from other cadastral object. For a more detailed explaination of UPI, refer Zulkifli et al, (2013).

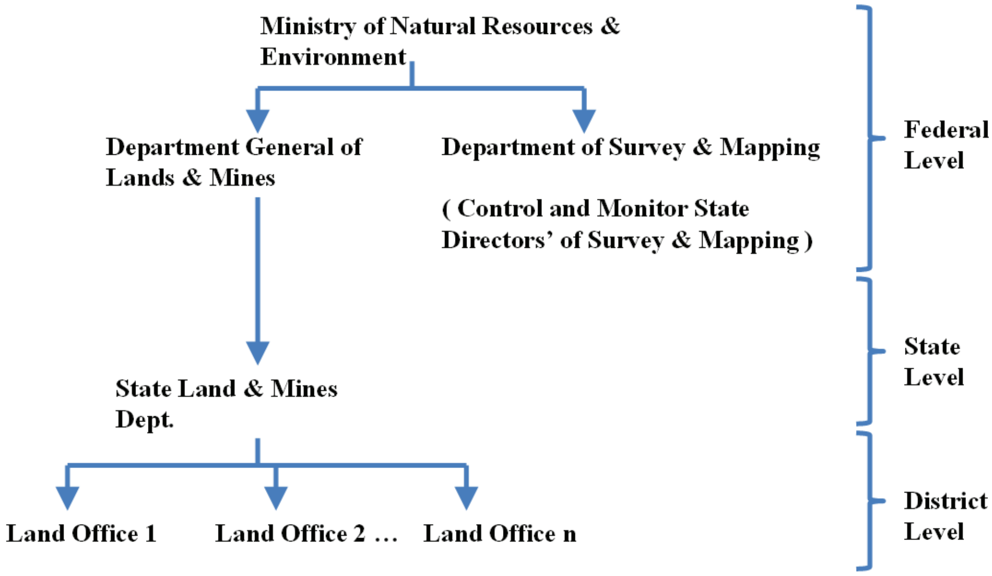

Figure 1: Organisational structure of land administration in Malaysia

The Malaysian Land (Group Settlement Areas) Act 1960**,** amended by Parliament in 2002 (GSA 2006), forms the basis for the inclusion of group parties into the country profile having rights to certain areas even without certified plan. Also included are customary or native titles (type of RRR) which are associated to customary areas. LADM supports various types of spatial representations, including textual descriptions. The concept of sub-division was introduced in Peninsular Malaysia on Jan 1, 1966 via the National Land Code 1965. Since then, the Strata Titles Act 1985 (STA 1985), which facilitates the sub-division of a building into parcels, together with numerous other amendments, have been enacted. The latest update that will bring about a significant change to the landscape of strata developments and common property management comes in the form of the Strata Titles (Amendment) Act 2013

(STAA, 2013), which is anticipated to come into force soon. The amendments under STAA 2013 include the introduction of the Electronic Land Administration System of Strata Titles, the designation of limited common property, and the creation of one or more subsidiary management corporations to represent the different interests of parcel proprietors. Figure 2 illustrates the various types of cadastral objects related to strata titles within a lot.

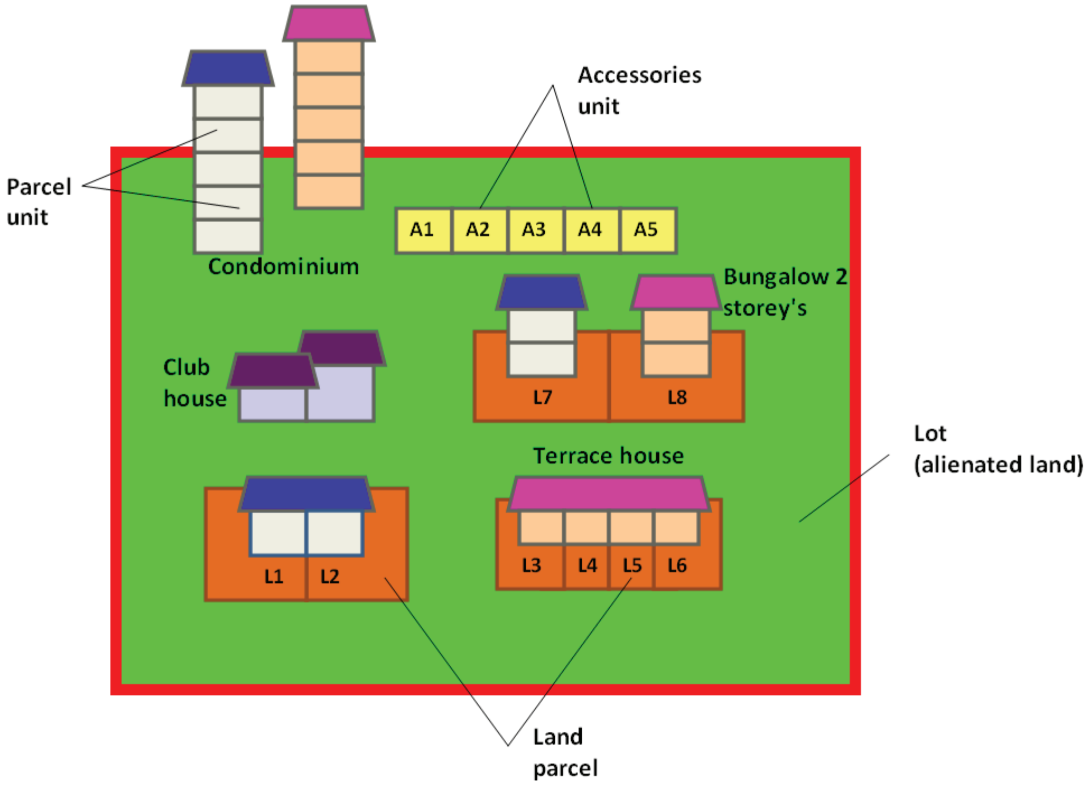

Figure 2: Various cadastral objects related to strata titles within a lot

3. MOTIVATIONS TO APPLY LADM-BASED STANDARDIZATION

Recent works suggest that the utilization of LADM international standard for cadastral domain is significant as mentioned by several researchers: Lemmen (2012), Van Oosterom et al (2011), Pouliot (2011), Hespanha (2012), and Ary Sucaya (2009). In this section we analyze the potential benefits of applying the LADM standard.

Domain specific standardization is needed to capture the semantics of the land administration domain on top of the agreed foundation of basic standards for geometry, temporal aspects, metadata and also observations and measurements from the field. A standard is required for communication between professionals, for system design, system development, and data exchange. This will enable land registry and cadastral organizations to use the components of the standard to develop, implement and maintain systems in an even more efficient way. Standardization is supportive and helpful in design and further development of land administration system. It is relevant to keep data and process models separated, this means that (inter-organizational) processes can be changed independently from the data sets to be maintained. The data model can be designed in such a way that transparency can be supported. This implies inclusion of source documents and inclusion of the names of persons with roles and responsibilities in the maintenance processes into the data model.

Standardization concerns identification of parcels, documents, persons, control points and many other issues. It concerns the organization of the registration and references between the various components. It concerns coding and use of abbreviations. It should be observed that all this is valid for both paper based and for digital land administration system. During analogue to digital conversion, many inconsistencies built up in a paper based system can appear. For an example, there can be parcels in the registry which are not on the map and the other way around. Such errors should be impossible, because a real right is always related to a person and to a piece of land in reality. The same is valid for the representation of this reality in a register and on a map. This type of inconsistencies should be impossible, but they exist. Measures have to be taken to avoid this in the future after computerization. There are many different reasons to specifically adopt the 2012 approved ISO standard 19152, LADM:

- contains the collective experience of experts from many countries (in ISO and FIG);
- took long time to develop in the FIG/ISO project team, but LADM is based on consensus and now adopted by ISO (and CEN);
- allows meaningful data exchange: within country, SDI-setting, and between countries;
- covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons (individuals of groups), etc.;
- allows integrated 2D and 3D representation of spatial units;
- supports both formal and informal RRRs; and
- link essential land information data to source documents, both spatial (survey) and legal (title, deed).

Realistically, being LADM compliant will seldom be the main reason to build a new land administration system in a country. However, every system does need smaller and larger upgrades and maintenances, and these are the moments to consider becoming LADM compliant. Papers and presentations by several authors held at the fifth LADM workshop in Kuala Lumpur (24-25 September'13) did mention very good reasons to consider LADM; e.g. the presentation by Kalantari et al, (2013). Application of LADM brings the following benefits: international compliance, cross jurisdictional data exchange, upgrading or new versions for existing systems, existing institutions ('do fit in well'), semantic compliance (definition of key concepts), structural compliance (agreed model patterns), feedback and improvements (during standard development, but also needed afterwards), and capacity building (LADM included in various curriculums). Thompson (2013) concluded that the LADM also provides an excellent growth path: from text, sketch and point parcels to full topology and 3D support (and same range of options available in administrative side of model). This is also the reason for UN-HABITAT (STDM) and FAO to use the standard.

4. DEVELOPMENT OF MALAYSIAN COUNTRY PROFILE

Based on earlier work and publications (Abdul Rahman et al 2011, Tan and Looi 2013, Zulkifli et al 2013), which have taken initial steps towards a Malaysian country profile, we have further developed the model. For the first time the Malaysian country profile is now based on inheriting from LADM classes. In this paper, 'MY_' is the prefix for the Malaysian country profile, covering both the spatial and administrative (legal) data modelling. Figures 3 and 4 give an overview of the developed model. The administrative part is adopted from the LADM standard, the spatial part contains various refinements (additional classes which will be explained). The model and design decisions on which the model is based will be elaborated on in this section. As explained in Section 2, the current cadastral system in Malaysia is still not able to answer several 3D situations as proposed by Stoter (2004), Thompson and van Oosterom (2010), Hassan and Abdul Rahman (2010). Although the 2D cadastre still plays a dominant role in land administration in Malaysia, specific needs for the registration related to 3D cadastre based on LADM specifications need to be investigated further. Therefore the proposed model includes 3D geometric descriptions. In Annex A, Figures A.1 and A.2 shows the detailed version of the UML class diagrams, note that in some cases the inherited attributes are shown; e.g. for MY_SpatialUnit, MY_Point, MY_Party, MY_RRR, etc. To illustrate the inheritance from the LADM classes in these cases (in Annex A and in the overview class diagrams in Figures 3 and 4), the MY_ classes have either in upper right corner the corresponding LA_ class name in italics or have the explicit inheritance arrow shown in the diagram. All classes in Malaysian model are derived directly or indirectly (via the inheritance hierarchy) from LADM classes.

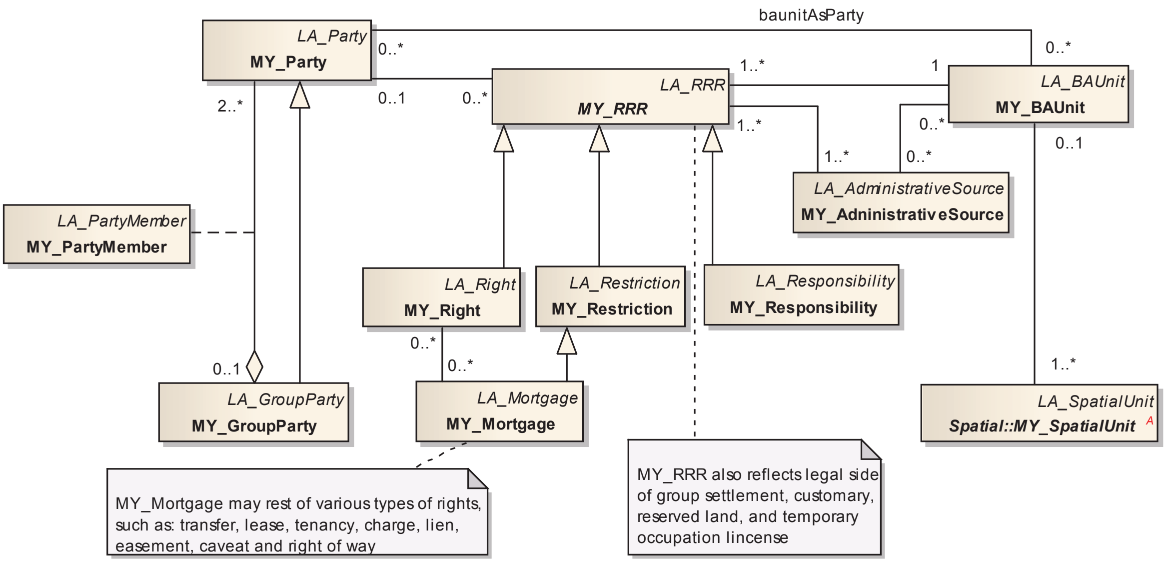

Figure 3: Overview of the administrative (legal) part of the Malaysian LADM country profile

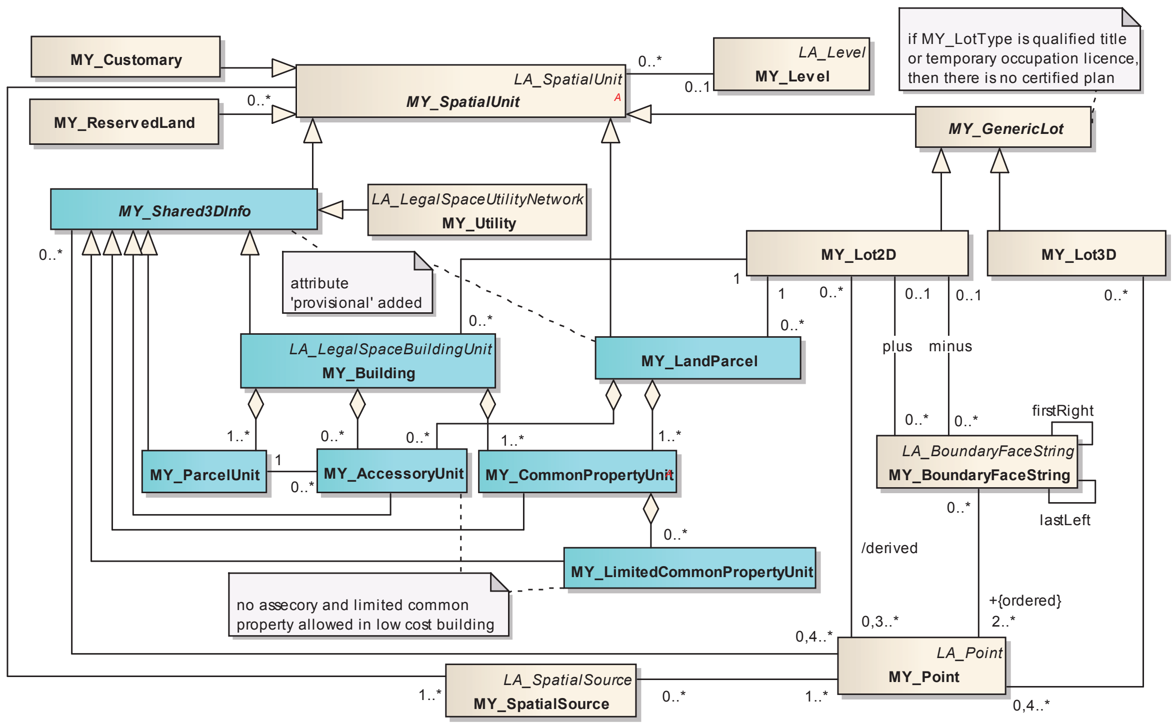

Figure 4: Overview of the spatial part of the Malaysian LADM country profile (blue is used for strata related classes)

Except source documents, all classes in LADM (and therefore also all derived classes in Malaysian country profile), are a subclass of VersionedObject and inherit all the VersionedObject attributes; see Annex A. The class VersionedObject is introduced in the LADM to manage and maintain historical data. As source documents cannot change, only new source documents can arrive, they are not versioned. The current land administration system in Malaysia does not yet support full history management, so this is a significant change. It is not only an important change for only for the land administration system itself, but it is also crucial for the future Malaysian information infrastructure, as others might need the functionality to refer to historic versions of land administration objects.

In the Malaysian country profile, there are some attributes, which are repeated after inhering them from LA_ class. The reason for this is that they have different multiplicity the same attribute has in the corresponding LA_ class. For an example, LA_AreaValue in MY_Lot3D class has 0 multiplicity because this class has no value for area and in MY_Lot2D the multiplicity of this attribute is [1..*]: indicating the presence of one or more area values. The original LA_ class (LA_SpatialUnit) for the area attribute has multiplicity zero and more [0..*]. Note that some example area types of LA_AreaValue are: officialArea, nonOfficialArea, calculatedArea, and surveyedArea.

In the proposed country profile, spatial units can be 2D or 3D. Traditionally, lots are 2D, but subsurface lots do already exist with 3D description with volumetric descriptions, but no 3D topology. The model has introduced an abstract class MY_GenericLot holding the attributes of a lot and this class has two specializations MY_Lot2D and MY_Lot3D, with their own attributes and structure. Currently MY_Lot2D is based on 2D topology with references to shared boundaries (MY_BoundaryFaceString). In the 3D, topology is not used: not for lots (MY_Lot3D), nor for strata objects. In the model one strata object type remains to be represented in 2D, MY_LandParcel (with building no more than 4 storeys). The other strata objects are all proposed to be 3D and therefore inherit form an abstract class MY_Shared3DInfo, with strata specializations (and mutual aggregation relationship): MY_BuildingUnit, MY_ParcelUnit, MY_AccessoryUnit, MY_CommonPropertyUnit, and MY_LimitedCommonPropertyUnit. As there can be several LimitedCommonProperty's in one CommonProperty, this is modeled as a part-of relationship to MY_CommonProperty (the aggregation class). In the class diagram, Figure 4, the blue classes refer to part of strata objects for better readability of the model.

Note that there are several abstract classes in the Malaysian country profile indicated in Italics: MY_SpatialUnit, MY_Shared3DInfo, MY_GenericLot. These classes are only supporting the modelling process, representing shared attributes and structures, and these abstract classes will not get any instances (and therefore no corresponding table in the database implementation). For MY_Shared3DInfo there is a geometry attribute (of type GM_Solid). Normally the 3D geometry in LADM is represented in LA_BoundaryFace, but given the fact that no 3D topology is used there is 1-to-1 association with the spatial unit (one of the specializations of MY_Shared3DInfo). So, it could be argued that the proposed country profile is ISO conforming, despite that absence of the class LA_BoundaryFace. Annex B Figure B.1 describes more detailed information concerning 2D and 3D geometry and topological aspects and the various design decisions for the model.

One of the important foundations of LADM is the fact that all information in the system should originate from source documents and that the association to the source document is explicitly included. In case of spatial source documents (usually certified plans) there are links with spatial unit and point tables: MY_SpatialSource has association with MY_SpatialUnit and MY_Point. In case of administrative source documents (usually titles) there are associations with right, restriction (incl. mortgage) and responsibility (RRR) and basic administrative unit. MY_AdministrativeSource associates with MY_RRR and MY_BAUnit. The LADM Malaysian country profile uses suID for spatial unit and sID for spatial and administrative source. Basically, suID in Malaysian country profile is based on Unique Parcel Identifier (UPI). sID for spatial source is certified plan number and sID for administrative source is title number. A note has been added in the country profile to indicate this.

In Malaysia, there is normally 1 to 1 relationship between BAUnit and spatial unit. However, there are some cases where one BAUnit (with same RRRs attached) has multiple Spatial Units: a combination of farmland with residential house (Group Settlement Act). Also, some status values of MY_Lot (e.g. 10, which indicates charting stage) relate to lots that do not yet have RRRs attached, to make this possible, the multiplicity of the association between spatial unit and BAUnit is 0..1 (optional) at BAUint side. In the future, the Malaysian land administration system can consider grouping of spatial units with same RRRs attached via a single BAUnit.

To make the model comprehensive and future proof, a wide range of spatial units can be supported including legal spaces for utilities (3D), customary areas, and reserved land (forest, wildlife areas). It should be noted that reserved land (forest, wildlife), are associated with their own RRRs, normally there is no overlap, but in some cases overlap can happen depending on state and type. The spatial description of reserved land is by text or sketches, but they may also be surveyed (or a combination of the above). The various types of spatial units are organized in levels. In this model we use MY_Level class to organize the various types of spatial units. For MY_Level, there is a type attribute which describe level type of the spatial unit. The type of spatial unit will include customary, lots (mixed land and road), building (parts, strata) and utilities. The codelist for this attribute can refer to MY_LevelContentType. Basically, MY_Level is a collection of spatial units with a geometric or thematic coherence. The following levels are proposed: level 0 for customary, level 1 for reserved land, level 2 for 2D lot, level 3 for 3D lot, level 4 strata, and level 5 for utility. In the involved classes a constraint has been added (third box in class diagram) to make this more explicit. For example; MY_Customary has a constraint: MY_Level.name = 'level 0'.

In case of some special types of lots there may be no certified plan; related to 'Qualified title' (only temporary boundary from sketch/demarcation by settlement officer/ pre-computation plan). Also strata with provisional block for building or land parcels for phased development are supported by marking them as provisional via additional attribute. In one scheme for building (3D), it also have provisional block. Based on Strata Titles Act 1985 (Section 4), provisional means: a) in relation to a proposed strata plan, a block in respect of a building proposed to be, or in the course of being, erected, for which a separate provisional strata title is applied for; b) in relation to an approved strata plan, such a block shown therein, for which a provisional strata title is to be registered; c) in relation to a book of strata register, such a block shown therein, for which a provisional strata title has been registered.

Based on spatial and non-spatial data modelling above, several classes have code list. In Malaysia, we have standard codes for features and attribute code (MS 1759: 2004). Malaysian standard codes basically cover the spatial part and rarely cover non-spatial part likes Right, Restriction, and Responsibility type. Figures 5 and 6 show the non-spatial and spatial codes. Newly proposed code lists for non-spatial package not captured in the current Malaysia standard are presented in Figure 5 and are mainly based on example code list values in ISO 19152 (LADM-Annex J, 2012). In most cases, Malaysian values are proposed for the well known LADM code lists. In future there may be a global (ISO or FIG or OGC) organization, maintaining code list and their values. In addition some new Malaysian specific code lists are proposed; e.g. MY_LotType, also with proposed code list values.

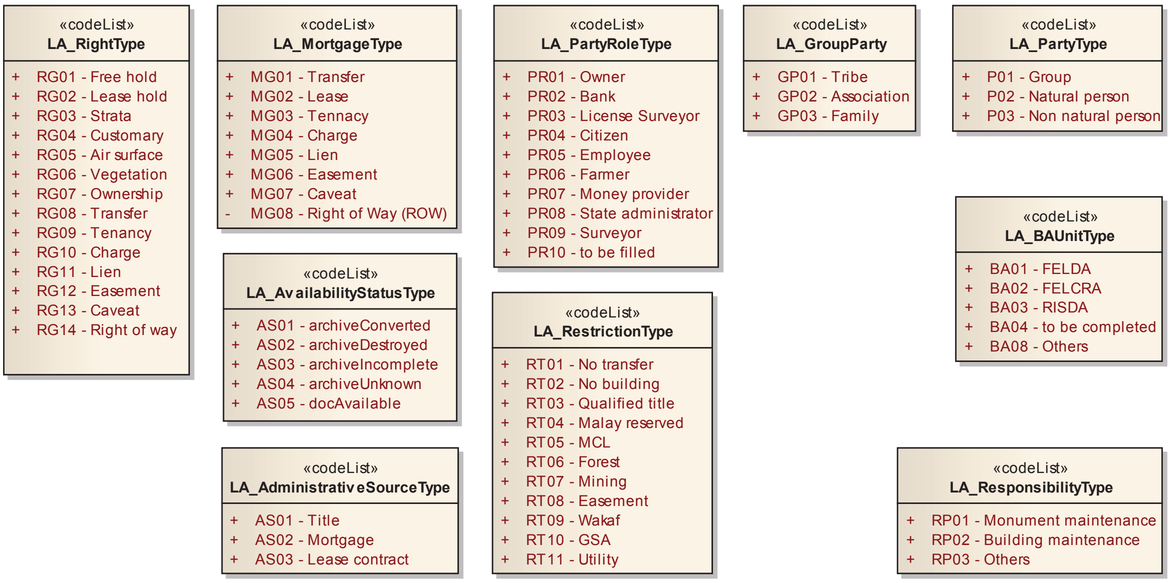

Figure 5: Code list with Malaysian values for non-spatial package (party and administrative package)

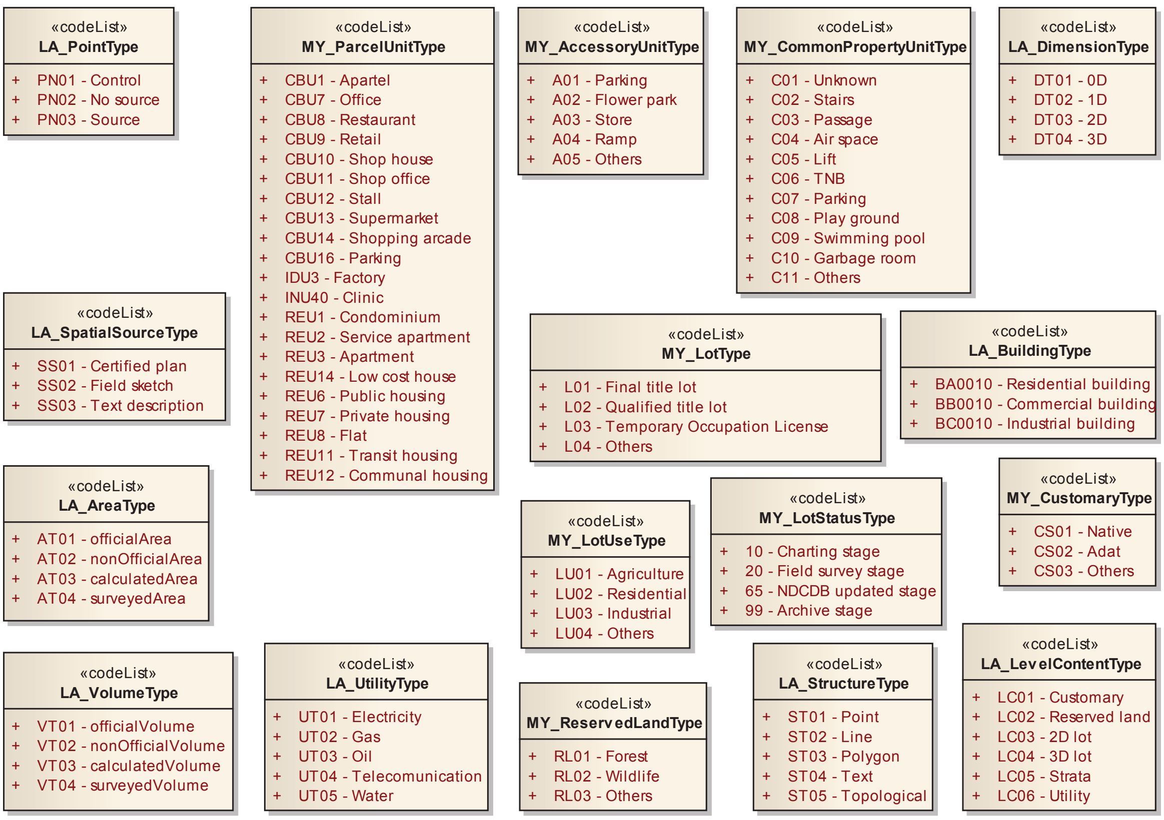

Figure 6: Code list with Malaysian values for spatial package (white: content equal to LADM)

5. CONCLUSIONS

This paper described the utilization of the Land Administration Domain Model (LADM), in particular the Parties, the Rights, Restrictions and Responsibilities (RRRs) and the relationship with spatial data for 2D and 3D Cadastral environment. The developed draft Malaysian country profile is available from http://isoladm.org (go to CountryProfiles and download the zipped EAP file MY-country_profile-LADM-v5.zip with the model).

Referring to the proposed conceptual model in this paper, LADM provides standardized class names for spatial and non-spatial data. For spatial data class, they have their own standard name called SpatialUnit. In the presented conceptual model, the Malaysian LADM country profile, SpatialUnit has a number of specializations, which are Customary areas, Reserved Lands, Lots (2D and 3D), Legal spaces Building (with various unit types, all in 3D), Land Parcels (strata title, which house no more than 4 storeys, in 2D) and Legal spaces Utilities (3D). Building Unit is also divided into three subclasses, which are Parcel Unit, Accessory Unit and Common Property Unit (which has two subtypes: normal and Limited Common Property Unit). Querying 2D spatial objects can be based on classes MY_Lot2D, MY_LandParcel, MY_Customary and MY_ReseveredLand. Meanwhile, we use MY_Lot3D, MY_Building, MY_ParcelUnit, MY_AccessoryUnit, MY_CommonPropertyUnit, MY_LimitedCommonPropertyUnit, and MY_Utility to query the 3D spatial objects. All geometry is obtained from MY_Point, which is associated with MY_SpatialSource. MY_Party, including groups and subclasses of MY_RRR can be used to query non-spatial data. All administrative information is linked to administrative source documents, such as titles, and included in the model via MY_AdministrativeSource. The UPI is the important to link between spatial and non-spatial data. New code lists (including code list values) for spatial and non-spatial data to improve the Malaysian standard are also proposed.

The proposed draft country profile based on the LADM provides a conceptual model for 2D and 3D cadastral situations for the relevant land administration agencies in Malaysia. In order to assess the developed Malaysian LADM country profile, a prototype based on the model has been developed. First step of the prototype development is the conversion of the conceptual into a technical model. It turned out that only relative minor modifications were needed. These modifications were usually minor details that were corrected (and included in the conceptual model as presented in this paper). The development of the technical model and the prototype is further documented in an accompanying paper (Zulkifli,et al., 2014). Last part of the development of prototype was to convert existing sample data and load this into the database with schema as specified in the technical model. In theory it should have been possible to use the appropriate tools to perform highly automated transformation of UML diagram (conceptual model), to database tables SQL DDL scripts for data storage or XML schema for data exchange format (using Enterprise Architect). However, it was decided to first experiment with more manual transformation from conceptual model to database table, to better assess the issues involved (e.g. define spatial indices/ clustering, transform generic ISO19107 geometry and topology specific database structures, identifiers generated by the system in addition to 'user identifiers', such as UPI, etc.). Future work will include:

- Assessing the draft model, and where needed refine, extend, correct the model (after discussions with other State and Federal Government Agencies, especially Land

Offices, Valuation and Property Services Department, and Town and Country Planning Department).

- Proposing an amendment of Section 5 of the National Land Code (NLC 1965) to extend the definition of land with airspace or marine space whether or not held apart from the surface of the earth' and in section 396(1) include calculation of volume in addition to area enclosed by (3D) boundaries, below, on or above the earth (land/water) surface.
- Create explicit rules for correct 2D and 3D representations, and quality checking 2D and 3D representations: closed spatial objects, no overlap/gap between neighbours.
- Explore possibilities for cadastral registration of network utilities (legal spaces above, below and on surface).
- Further investigating the potential use of 3D topology per building, to represent the various units within the building that share faces. Instead of giving each unit its own 3D geometry (and duplicating the shared faces between neighbours).
- Investigate the integration of administrative/legal data (Land Registry) and spatial data (JUPEM) via Malaysian Information Infrastructure (DSI), with the following two main goals: 1. Consistency of data (data quality aspect), and 2. Combined query (better, more complete services)
- Explore how to develop and use the Malaysian Information Infrastructure to realize this. To apply the LADM for information integration among various agencies

REFERENCES

Abdul Rahman, A., Teng, Chee Hua and Van Oosterom, P.J.M. (2011). Embedding 3D Into Multipurpose cadastre. In: FIG Working Week 2011- Bridging the Gap between Cultures. 18-22 May 2011. Marrakech, Morocco.

Ary Sucaya, I.K.G., (2009). Application and validation the Land Administration Domain Model in a real life situation (A case study in Indonesia). MSc Thesis. Delft University of Technology, Delft, the Netherlands.

Bogearts, T. and Zevenbergen, J., (2001), 'Cadastral Systems – Alternatives', in: 'Computers, Environmentand Urban System', Theme Issue 'Cadastral System', p. 325-337, Volume 25, number 4-5, 2001, Elsevier Science, New York.

GSA (2006). Land (Group Settlement Areas) Act 1960, Incorporating all amendments up to 1 January 2006

Hassan, M.I. and Abdul-Rahman, A. (2010). An integrated Malaysian cadastral system. FIG Congress 2010. Sydney. Australia.

Hespanha, J.P., (2012). Development Methodology for an Integrated Legal Cadastre-Deriving Portugal Country Model from the Land Administration Domain Model. Ph.D Thesis. Delft University of Technology, Delft, the Netherlands.

ISO 19152:2012 'Geographic information - Land Administration Domain Model (LADM), version 1 December 2012

Kalantari, M., Rajabifard, A., Urban-Karr J., and Dinsmore K. (2013). Bridging the Gap between LADM and Cadastres. In: Proceedings of the 5th FIG Land Administration Domain Model Workshop, 24-25 September 2013, Kuala Lumpur, Malaysia, p. 381-

390.
Lemmen, Ch. (2012). A Domain Model for Land Administration. PhD Thesis. Delft University of Technology, Delft, the Netherlands.
MS 1759: 2004. Malaysian standard geographic information/geomatics – features and attribute codes.
Pouliot J., Marc V., Abbas B. (2011). Spatial Representation of Condominium/Co-ownership: Comparison of Quebec and French Cadastral System based on LADM Specifications. 2nd International Workshop on 3D Cadastres.
Stoter, J.E. (2004). 3D Cadastre. Ph.D. Thesis. Delft University of Technology, Delft, the Netherlands.
STA (1985). Strata Titles Act 1985.
STAA (2013). Strata Title Amendment Act 2013.
Tan, L.C. and Looi, K.S. (2013). Towards a Malaysian Multipurpose 3D Cadastre based on the Land Administration Domain Model (LADM) – An Empirical Study. In proceedings of the 5th FIG Land Administration Domain Model Workshop, 24-25 September 2013, Kuala Lumpur, Malaysia, pp. 109-131.
Thompson R. and van Oosterom, P. (2010). Integrated Representation of (Potentially Unbounded) 2D and 3D Spatial Objects for Rigorously Correct Query and Manipulation. 5th Intenational 3D GeoInfo Conference, November 2010, Berlin, 17 pp.
Thompson R. (2013). Progressive Development of a Digital Cadastral Data Base. In: Proceedings of the 5th FIG Land Administration Domain Model Workshop, 24-25 September 2013, Kuala Lumpur, Malaysia, pp. 361-380.
Van Oosterom, P.J.M, Lemmen, C.H.J, Uitermark H., Boekelo G., and Verkuijl G., (2011). Land Administration Standardization with focus on Surveying and Spatial Representations. In: Proceedings of the ACMS Annual Conference Survey Summit, San Diego, 28pp.
Zulkifli, N.A., Abdul Rahman, A., and van Oosterom, P. (2013). Developing 2D and 3D Cadastral Registration System based on LADM: illustrated with Malaysian Cases. In: Proceedings of the 5th FIG Land Administration Domain Model Workshop, 24-25 September 2013, Kuala Lumpur, Malaysia, pp. 447-464.
Zulkifli, N.A., Abdul Rahman, A., Jamil, H., Teng C.H., Tan, L.C. and Looi, K.S., Chan K.L., and van Oosterom, P. (2014). Development of a prototype for the assessment of the Malaysian LADM Country Profile. Abstract submitted to FIG Congress 2014, Malaysia.

ANNEX A. Detailed LADM country profile Malaysia

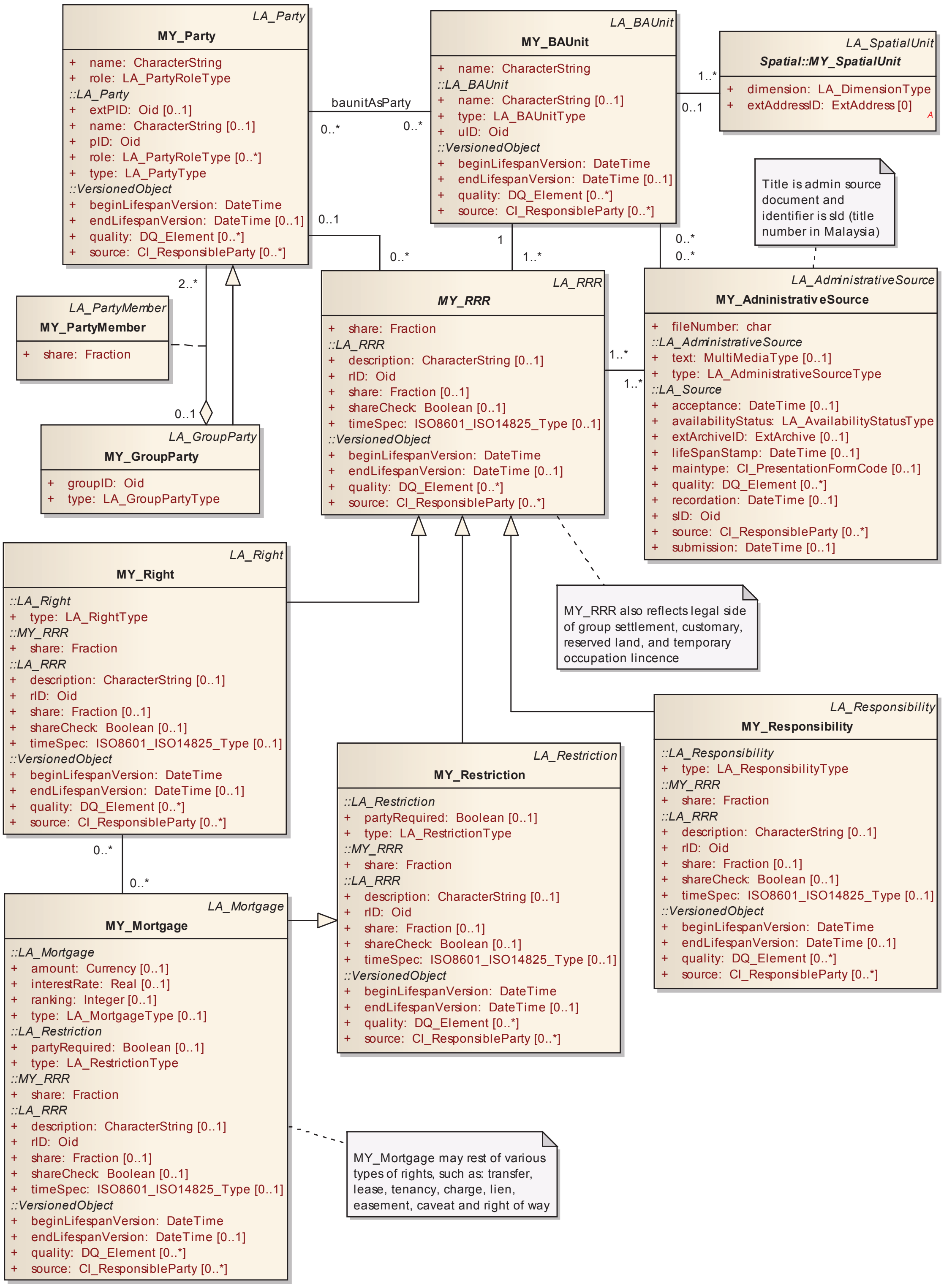

Figure A.1: Details of non-spatial part of the model (mainly showing LADM inheritance)

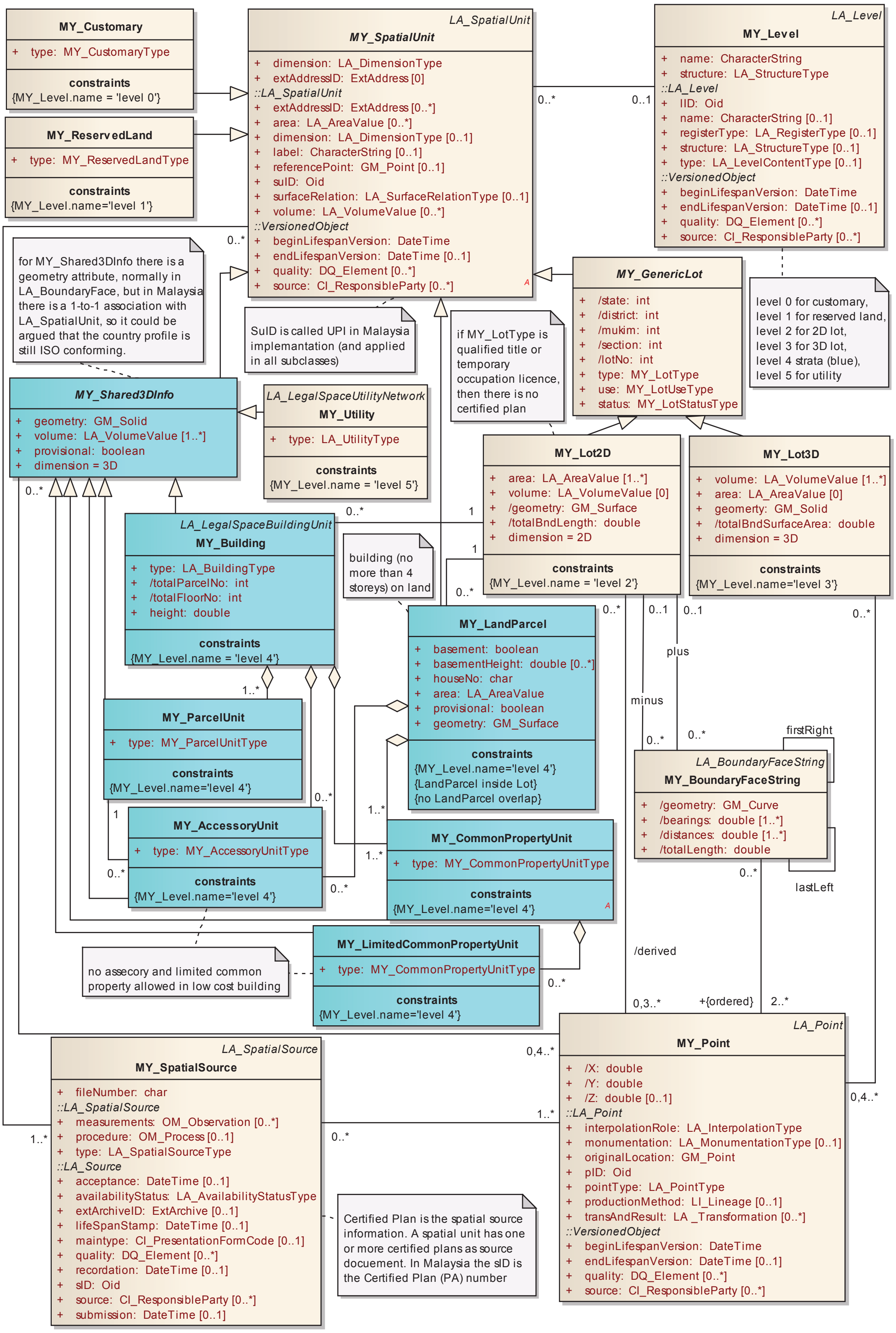

Figure A.2: Details of spatial part of the model (several refinement classes)

ANNEX B. 2D Topology/geometry model

This annex contains some more detailed aspects of modeling 2D topology and geometry in the proposed Malaysian LADM country profile. Discussed are aspects of which topological references to store, where to store (or derive) geometry representations, and avoiding redundancy.

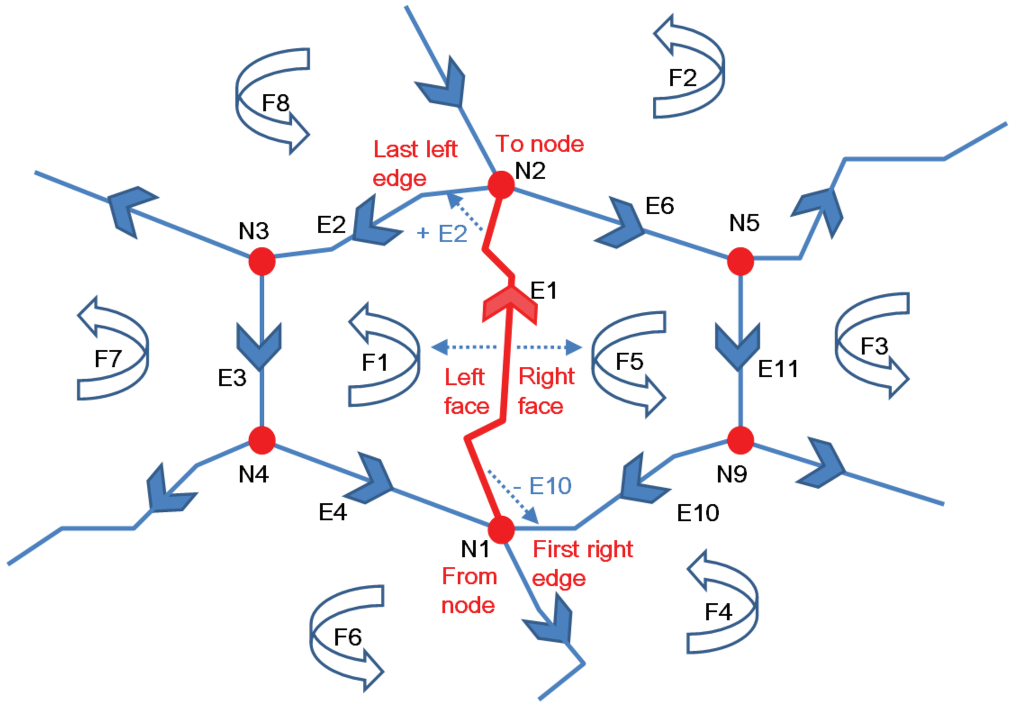

Figure B.1: 2D Topology model as used in the Malaysian country profile

Topological boundaries do not intersect and do meet other boundaries at begin and end nodes. All topological boundaries are used once in positive and also exactly once in negative direction. Unless the boundary is on the edge of the domain, then it is used only once. All associated boundaries together form one or more non-intersecting rings defining at exactly one outer ring (with counter-clockwise orientation) and optionally one or more inner rings (with clockwise orientation). For 2D lots topology is used: based on 3 primitives node (point), edge (MY_BoundaryFaceString), face (lot). In general, a topological data model manages spatial relationships by representing spatial objects (point, line and area features) as an underlying graph of topological primitives – nodes, edges and faces. Topology is a set of rules and behaviors that model how points, lines and polygons share coincident geometry. For an example, adjacent features, such as two lots, will have a common boundary between them. They share same edge. Topology references (in MY_BoundaryFaceString) are:

i) edge-node = fromNode and toNode (and intermediate points),
ii) edge-edge = firstRightEdge and lastLeftEdge, and
iii) edge-face = rightFace and leftFace.

The question which arises is, where to store the geometry in lot (face), boundary (boundary), and point tables? In order to avoid redundant information, the geometry of the 2D lot will be only stored in the MY_Point class and the other geometries can be derived: the GM_Curve in the MY_BoundaryFaceString (and the GM_Surface in the MY_Lot2D). Note that more conceptual level geometry types are used in the model: GM_Solid, GM_Surface, GM_Curve, and GM_Point (from ISO 19107). This is independent from any implementation platform. In addition to derived geometries, to avoid redundancy, there are more derived attributes (bearing, lengths in boundary face string) and associations (MY_Lot2D – MY_Point) in the model. The reason, why derived attributes and associations (lot-point) are used in the model, is to avoid double storage in the face (geometry) and edge (line) objects. In the transformation to implementation it has to be decided how these will be implemented in the database, one option is to provide procedures for the derivation and use these in database SQL view (a less preferred alternative is explicit redundant storage).

Currently DSMM represents a boundary (edge) with a straight line segment with no intermediate points, but it is proposed in the model to also have potential intermediate points, running from node to node (node = location where 3 or more boundaries meet). It is good to have intermediate points as a boundary, because this will result in less records, a more compact representation with less repeated left/right references (for a chain of straight line segments between two topological nodes, all left/right references must be equal).

BIOGRAPHICAL NOTES

Nur Amalina Zulkifli is a researcher at the Department of Geoinformation, Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia (UTM), Skudai, Johor in Malaysia. She received a degree in Surveying Science and Geomatics from Universiti Teknologi MARA (UITM) in 2008. She is currently working on her MSc research concerning Land Administration Domain Model (LADM) for 2D and 3D cadastral registration.

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Tan Liat Choon is an Assistant Director of Survey at Department of Survey and Mapping Malaysia (JUPEM) since 16 July 2003. He first attach as Assistant Director with Malaysian Centre for Geospatial Data Infrastructure (MaCGDI). He is now with Database Section, JUPEM. He has studied on "Towards Developing a Three-dimensional Cadastre for Threedimensional Property Rights in Malaysia" as his PhD thesis. His research interests are 3D property legislation in Cadastral Survey and Mapping Registration System and Land Registration System. He holds MSc. Degree in Land Administration and Development (2002), a BSc. Degree in Land Survey (1998), and a Diploma in Land Survey (1996) all from Universiti Teknologi Malaysia (UTM), and also certificated in Land Survey (1993) from Politeknik Kuching Sarawak, Malaysia.

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Peter van Oosterom obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, The Netherlands. In 1990 he received a PhD from Leiden University. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, he is professor at the Delft University of Technology (OTB institute) and head of the section 'GIS Technology'. He is the current chair of the FIG working group on '3D-Cadastres'.

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