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Improvement of the Korean LADM country profile to build a 3D cadastre model

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ABSTRACT

In modern societies, considerable efforts have been devoted in building an effective land management model. In 2012, the Korea country profile of the Land Administration Domain Model (LADM) was proposed to the ISO/TC211. In 2014 'the special Cadastral Resurvey Act' was announced. This law includes the representation of 3D partitioned superficies for buildings and underground facilities into the land information system.

In this study, a 3D land administration model is proposed using a cadastral resurvey form, including the representation of 3D physical properties and 3D rights. The new 3D cadastre model can contain underground utility and superficies information to present the physical and legal information on both buildings and underground features. The shape of land units and terrain, and azimuth are also included as secondary information on features in this new model. Thus, the proposed 3D new version of the Korean country profile of the Land Administration Domain Model would be the next generation land administration model in Korea to represent all types of Cadastre information.

1. Introduction

Several countries, such as Singapore and Malaysia, recognized the limits of the representation of legal ownership and property information into a 2 Dimensional (2D) cadastre. This concerns information management for high-rise buildings and underground facilities. The International Federation of Surveyors (FIG) has organized a series of International FIG Workshops on 3D cadastres, in which the elements of 3D cadastre have been discussed (MLTM, 2009). One of the emerging topics discussed during the 'Second International Conference on 3D cadastre' was on the representation of objects and related rights into a 3 Dimensional (3D) cadastre (Lee et al., 2014).[1]

A 3D cadastral system is required to register the property rights of 3D features. Particularly because the development of underground space has expanded, the current 2D parcel system in Korea has encountered difficulties in effectively managing and protecting the ownership of the real estate (land, buildings and infrastructure) (Lee and koh, 2007; Park et al., 2009).

The Ministry of Land, Infrastructure and Transportation (MOLIT) in Korea has conducted a variety of research projects to establish a national policy about a cadastral system and has proposed an extended Land Administration Domain Model (LADM) country profile for Korea. The first version of the Korean country profile of LADM is published in (ISO, 2012); this first version concerns a 2D cadastral registration system. A cadastral system may express the land use status, which is undergoing or ongoing continuous development and diversification. Complex land use situations result in complicated 3D land ownership situations. Systematic registration, research on 3D cadastre is actively being conducted in order to design and develop new approaches, models, systems and applications for registration of 3D legal objects-with attention to legal, organizational and technical aspects (Williamson et al., 2010; Aien et al., 2013; Stoter et al., 2013; Jazayeri et al., 2014). And with special attention to visualization aspects (Shojaei et al., 2013).

Because land use expanded to space and underground areas, particularly in urban areas, both 3D rights (superficies) and physical objects (buildings and underground utilities) are required to be

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[1] Held in Delft, the Netherlands, in 2011.

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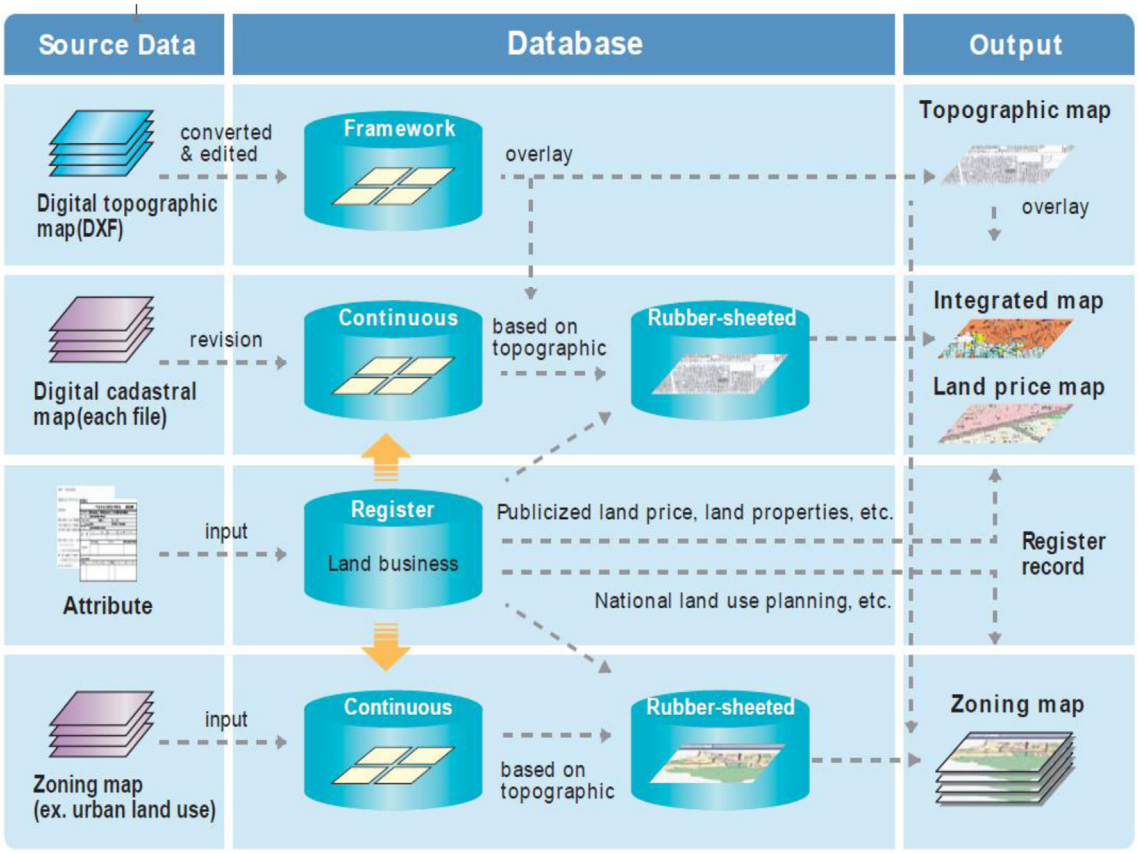

Fig. 1. Database of the KLIS (Shin and Kwak, 2013).

registered in the cadastral book in Korea. The cadastral book is the legal documentation where details of the ownership, the tenure, the dimensions and location of land parcels, the land use, and the value of individual parcels are maintained and published. Therefore, the government of Korea established a new cadastre resurvey law including new requirements for support to the management of 3D land information. The main purpose of this paper is to present the evolution from the 2D Korean land administration model into the 3D cadastre model allowing the inclusion of 3D information on 3D legal and physical objects. In particular, new types of spatial units are investigated. Those new spatial unit types allow the representation of 3D objects and rights, including centroid, metadata, result of surveyed cadastral information, and 3D characteristics of land (MLTM, 2012).

2. 2D Korea LADM

2.1. Korea land information system

Land administration in Korea is organised into three parts: cadastral management, ownership registry, and land use management. The legal foundation and executing body differs for each part. This institutional setting resulted in an environment where information systems function and operate 'exclusive' rather than 'co-operative'. The cadastral management system provides public access to a factual relation of land boundaries with high positional accuracy based on land surveys.

The Korea land information system (KLIS), finds its legal foundation in the Cadastral Act. Within the MOLIT, the National Spatial Data Infrastructure Center (NSDI Center) is responsible for the maintenance and data quality of the KLIS. There are two main document types involved in the cadastral management system core: 'Land Registry' and 'Cadastral Map' representing the boundaries of the parcels.

The land ownership registry is a system that shows the intangible relation of ownership of each land parcel; this system is under the control of the supreme court based on the 'Registration of Real Estate Act'. The supreme courts have launched several digital information systems for land ownership management since 1994, and these systems began full operation in 2002. The land use management system is related to land use policies, land appraisal, land transactions, and land use planning with several laws and government authority serving as the legal basis. These two systems are co-operative. For example, the changes in land ownership in the land ownership registry system will be transmitted to the land use management system and the changes in land parcel such as split and merge will be transmitted to the land ownership registry system.

KLIS is one of the management systems that supports local governments in land administration. Data, once produced at the local government level, are delivered to the regional and central government to support the decision-making process on land policies. Public services are provided at the local, regional, and central government level through the internet or through a specially designed portal website. Fig. 1 shows the process of building the cadastral database, which consists of a digital cadastral map and registered attributes that is then overlayed on a digital topographic map.

2.2. LADM country profile in Korea

The existing cadastral data model, a domestic standard, is integrated as the Korean LADM country profile in ISO 19,152 (ISO, 2012). See Fig. 2 for a representation of the country profile in a

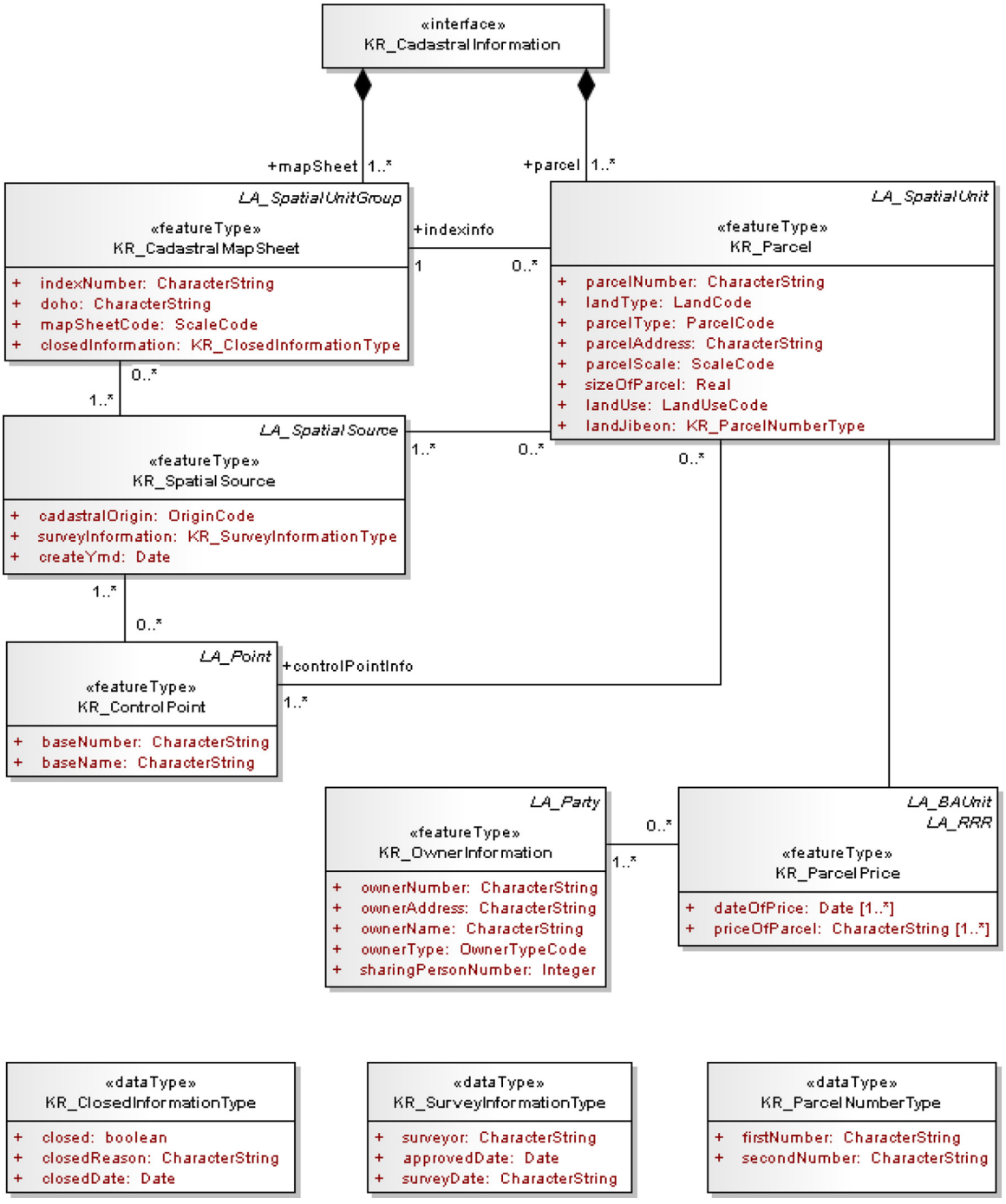

Fig. 2. Korean LADM country profile (ISO, 2012).

UML[2] Diagram. In Fig. 2, the prefix of 'KR' means Korea and 'LA' is the ISO prefix for land administration. The core information class is a parcel (KR_Parcel). Parcel attributes include the land parcel number, land type, parcel type, parcel address, parcel scale, area of parcel, and land use. The Korean LADM country profile with minimal information is considered the core information required for the implementation of the cadastral system. The profile is a flexible profile that enables all related systems to adopt it.

As previously noted, the Korean land administration is primarily conducted by KLIS. The Korean LADM country profile is required to encompass the KLIS information such as parcel attribute and map. Detailed information on each class is described in Table 1. The basic classes in the Korean LADM country profile include the parcel class, the cadastral map sheet class, the spatial source class, the control point class, the owner information class, and the parcel price class, which are shown in Fig. 3. The cadastral information class is an abstract class, which is a combination of the parcel class and the cadastral map sheet class (refer to Table 1). In the parcel class, owner information, parcel price, and control point are used. In addition, the spatial source is used with a map sheet and a parcel sheet.

[2] UML is the Unified Modeling Language.

Table 1
Description of Korea LADM Classes (Kim et al., 2013).

Class	Description
Cadastral information (KR_Cadastral Information)	The highest class including all information regarding parcel and cadastral map sheet classes
Parcel (KR_Parcel)	The core class containing information on parcels. This includes attributes of land parcel number, land type, parcel type, parcel address, parcel scale, size of parcel, and land use
Cadastral map sheet (KR_CadastralMapSheet)	Information regarding cadastral map sheets including map sheet index number, map sheet number, map sheet scale, and map sheet closed information
Spatial source (KR_SpatialSource)	Attribute information shared by the cadastral map sheet and control point classes. This includes attributes of cadastral origin, surveyor information, and creation date
Control point (KR_ControlPoint)	Attribute information regarding control points. This includes base number and base name
Owner information (KR_OwnerInformation)	Information regarding parcel owners including attributes of owner registration number, owner address, owner name, owner type and the number of persons sharing
Parcel price (KR_ParcelPrice)	Parcel price information including attributes of parcel price and the parcel price calculation date
Closed information type (KR_ClosedInformationType)	These data are generated if the map sheet is closed because of parcel relocation. Attributes include the map sheet closure Y/N, the reason for closure, and the closed date
Survey information type (KR_SurveyInformationType)	Information regarding parcel surveyors. Attributes include the surveyor, the approved date, and the survey date
Parcel number type (KR_ParcelNumberType)	Information regarding parcel number types. Attributes include the first number and a second number

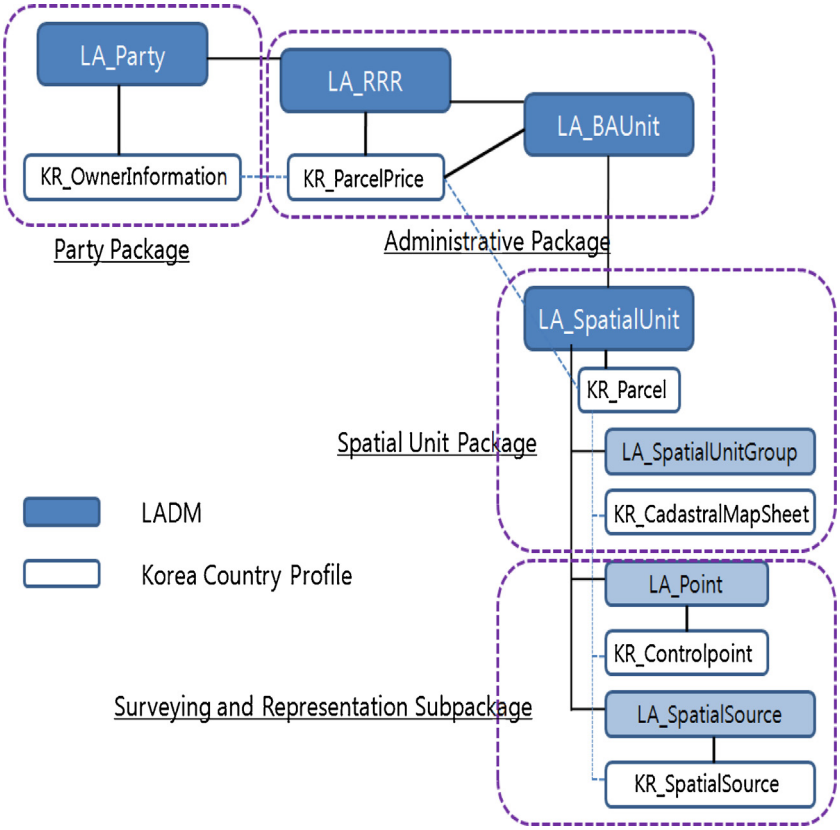

Fig. 3. Basic Classes of Korean LADM country profile (Kim et al., 2013).

3. Cadastral resurvey with a 3D component

In urban areas, a complex relationship exists between rights and responsibilities in cases where buildings and utility and transport infrastructure are inter related. With the existing 2D country profile, the issue is how to register and present the 3D rights in land administration/cadastral information (Oosterom et al., 2006; Jeong et al., 2012). The 2D Korean LADM country profile does not support the 3D representation of rights and physical objects because the profile is limited to 2D parcel information. In addition, cadastral information is currently managed separately within the cadastral map and the land registry in Korea.

In Korea, the debate on the 3D cadastre has started for the cadastral resurvey. The special cadastral resurvey law that was announced in 2014 contains the 3D superficies at 'act 2 (Parcel Investigation)' to enforce the cadastral resurvey project. In particular, 3D information including buildings, underground structures, and facilities should be included in the resurvey form to maintain the 3D superficies.

The resurvey includes the revision of information on land owners, parcel numbers, categories of land use, areas, boundaries with coordinates, buildings, location of underground structures, and publicly notified individual land prices (Lee and Kim, 2012). The model is not a parcel-based but based on a new spatial unit that represents 3D objects and underground structures. Detailed

WRITTEN INVESTIGATION FOR PARCEL

※ Administratitive Unit

	classification	Land Category	Area	Owner Information		note
				Name	Address	
List for Land	land book	Site	200	Shin Yoon ho	880-4, bangbe 4-dong, seocho gu, SEOUL	n
	land ownership registry	Site	210	Shin Yoon ho	880-4, bangbe 4-dong, seocho gu, SEOUL	n

①	classification	Parcel Number associated	structure	use	number of stories (above/below)	building area (㎡)	building to land ratio	Owner Information		note
							floor area ratio	Name	Address	
List for Building	building book	880-4	concrete	house	2/1	400	200 % / 150 %	Kim Ok-Gil	570-1, sawoo-dong, gimpo,	-
					/		% / %			
					/		% / %			
					/		% / %			

List for Landuse	land use zoning	second level urban distict, general residential zone
	developing plan	building hight zone, cutural facility area

< 표준양식 >

(좌표)

Actual Condition Investigation for LAND	Actual Condition	Road Condition	terrain	other structure
	commerical area	one sided contact	gentle slope	-

Actual Condition Investigation for BUILDING	Parcel Number associated	structure	use	number of stories (above/below)	building area (㎡)	Owner Information		note
						Name	Address	
	880-4	concrete	shopping	2/2	200 / 200	M-Won	570-1, sawoo-dong, gimpo,	-
				/	/			
				/	/			
				/	/			

② Actual Condition Investigation for UNDERGROUND STRUCTURE /UTILITIES	Parcel Number associated	Name	Superficies				Structure					etc
			purpose	area	scope	period	track	M.F	passage way	shopping center	use · profit	
	880-4	Kon M-Won	lease	100	30	10 year	-	-	-	-	-	-

contents of investigation				CONTENT of SURVEY			reason/comment		
	data investigation	date	2012. 1 .1		date of notification	. .		unsettled reason	
		name	Park Jawon		date of resurveying	. .			
	field investigation	date	2012. 3. 1		date of 2nd notification	. .			
		name	Song MinJu		date of 2nd resurveying	. .			
	Comment	-			date of 3rd notification	. .		surveyor comment	
					date of 3rd resurveying	. .			
				survey	surveyor				
					date of surveying				
				inspection	inspector				
					date of inspecting				

Fig. 4. Written Parcel Investigation Form for parcel and building (Shin and Kwak, 2013).

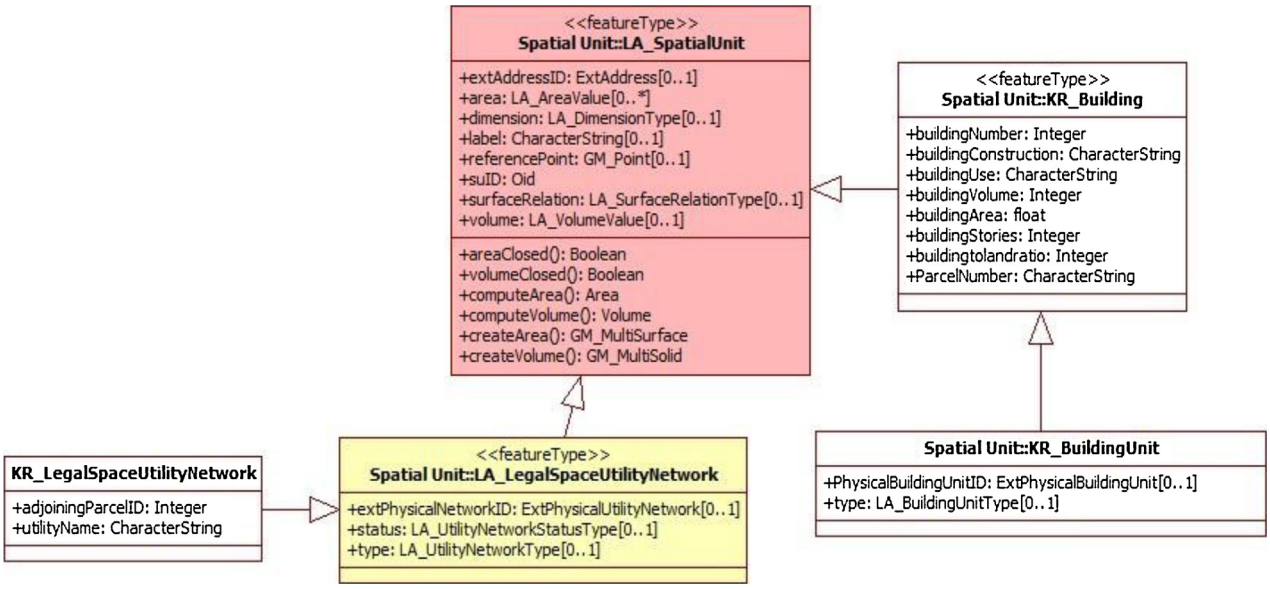

Fig. 5. Adding attribute to SpatialUnit Class.

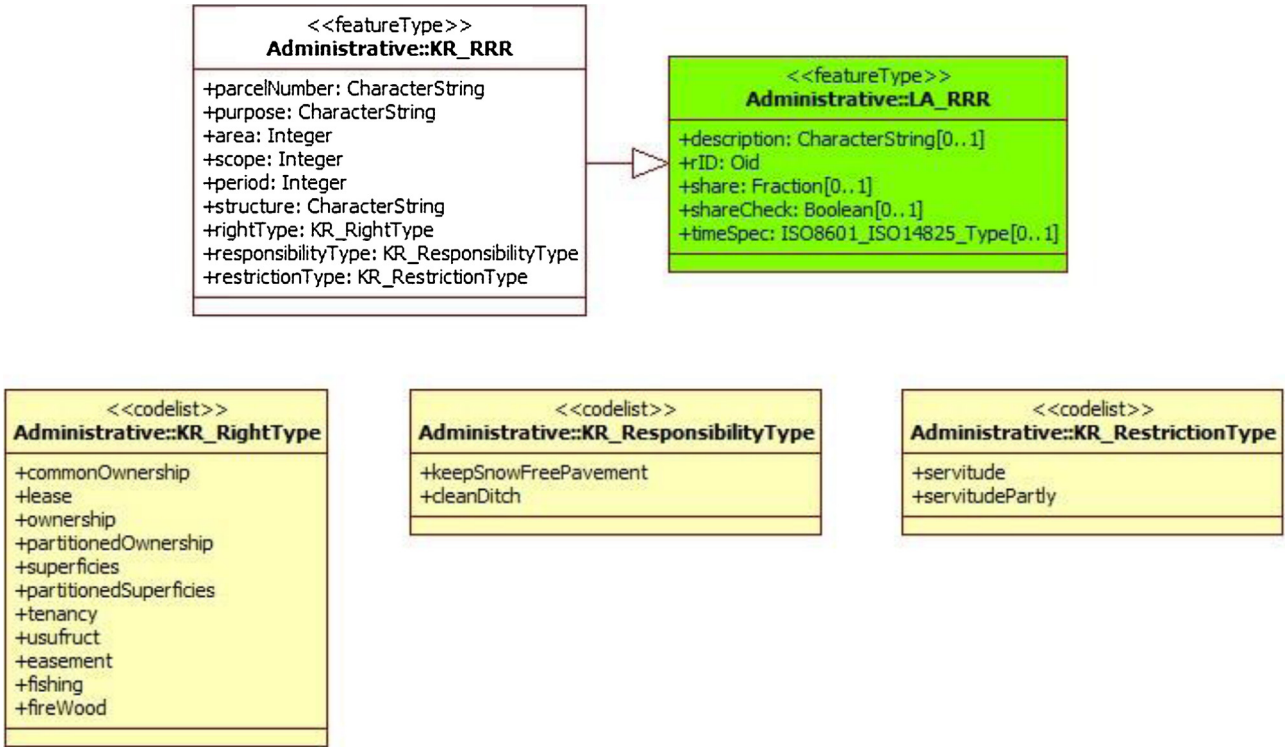

Fig. 6. Adding attributes to RRR.

information should be registered in a cadastre based on the 'enforcement regulations of act 13' for Parcel Investigation as follows. In particular, building information, underground structures/utilities, and partitioned superficies requires 3D information. The attributes are as follows.

- Building information (structure, use, floor area ratio, building to land ratio, and number of stories);
- Underground structures/utilities information; adjoining parcel ID, and names of utilities; and
- Superficies; scope, reason, purpose, and period.

According to the special act, buildings and underground structures should be investigated and registered on the Parcel Investigation (PI) form after updating its location. See Fig. 4. The outcome of this study would be one of the opportunities to improve the weakness of the current land information management system. In addition, the PI form enables the collection of high quality information that is related to 3D rights in land with high accuracy by buildings and underground utilities information in the investigation form (Fig. 4). 3D right information is easily integrated with other spatial information for utility management and represents the superficies of physical objects. In Fig. 4, boxes are drawn to show the information managed by 3D components.

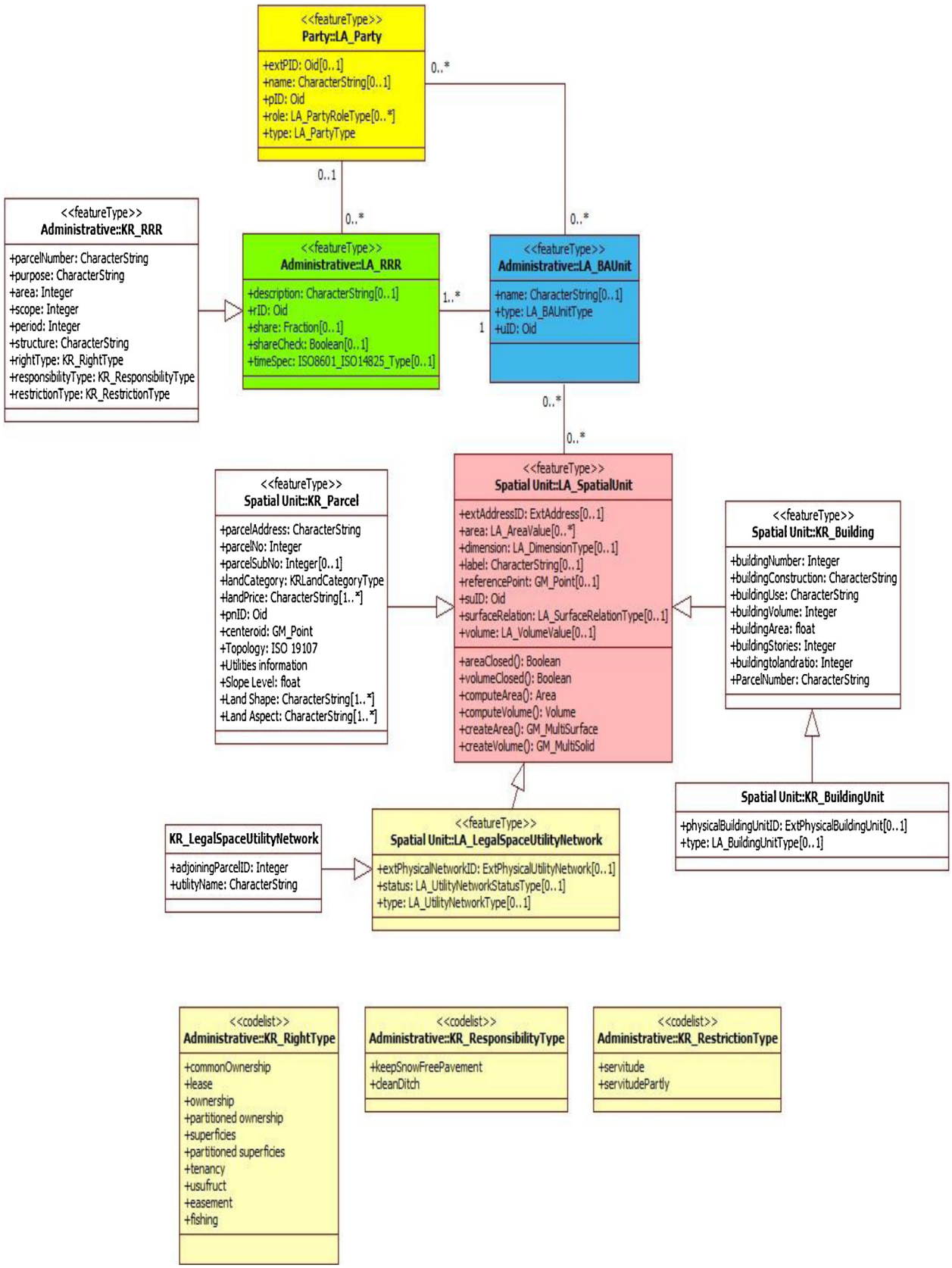

Fig. 7. New Korean LADM country profile 2015 (with 3D support).

4. The new Korean LADM country profile

Starting from the existing LADM country profile, the main modifications are as follows. First, the spatial unit class includes building information and underground facilities (Fig. 5). The KR_Building class and the KR_LegalSpaceUtilityNetwork class are newly added. The KR_Building class inherits attributes from the LA_SpatialUnit class and adds various building attributes. The KR_BuildingUnit class is also added to represent individual residencies or rooms in a building. The KR_BuildingUnit inherits attributes from the KR_Building class. The KR_LegalSpaceUtilityNetwork class inherits attributes from the LA_LegalSpaceUtilityNetwork class and specifies the utility name and adjoining parcel information. Especially, the physical objects such as buildings have their own space. However, utility networks are located above and under these physical objects and have their own space so that their existence can be represented legally. Therefore, utility network has the wording "LegalSpace" in its class name.

Second, the KR_RRR class includes codes as defined for superficies, constraint, and responsibility attributes as the Right section from which attributes are acquired from the cadastral resurvey form. The KR_RRR class inherits from LA_RRR class and adds the Right information including Right, Responsibility, and Restriction types (Fig. 6). The Right type in Korea includes common ownership, easement, lease, easement, ownership, partitioned ownership, superficies, partitioned superficies, tenancy, usufruct, and fishing. The Responsibility type includes keeping a snow free pavement and cleaning a ditch, and the Restriction type includes servitude and servitude partly.

The final suggested country profile is shown in Fig. 7. The KR_RRR is the main elementary class to present land relation rights and duties in the LADM. Rights (Ownership, condominium ownership, superficies, and easement) are added to present 3D relationship rights and duties in the code table for LA_RRR. The KR_Parcel class is the basic spatial unit of land administration, and modified in order to include 3D information such as Utilities Information, Slope Level, Land Shape, Land Aspect, Topology, and Parcel Centroid. The KR_Building and KR_BuildingUnit classes inherit from the LA_SpatialUnit class, and manage 3D information such as Building Number, Building Construction, Building Use, Building Area, and Building Volume. The KR_Cadastral Map Sheet class in the 2D Korean LADM country profile (see Fig. 2) was removed because it is no longer used in the field.

5. Conclusion

The Korean government is currently promoting policies to integrate databases and systems through the national spatial information integration system with cadastral advancement (previously known as the cadastre reinvestigation) and the administration information unification system. Sharing of land information is hindered by an incompatible exchange formats between organizations involved in land administration. Enabling the cadastre to bridge the technology gap requires the development of standards to enable compatibility between cadastral information and other spatial information.

In Korea, 2D information was maintained in the previous LADM country profile. However, more information including 3D attributes of the land and the buildings is required through the cadastral resurvey because complex legal relations between buildings and underground facilities have emerged. In this research, a new 3D Korean LADM country profile is proposed, in which several attributes are newly added such as survey information, 3D attributes, and 3D rights to improve land registration and cadastre administration. In addition, it is anticipated that the proposed 3D Korean LADM country profile will be applicable to other Asian countries for land management with 3D acts or regulations. Furthermore, the 3D cadastral model would be useful for positioning resources in various fields such as emergency and disaster prevention.

In addition to these advances, there are limitations to applying the new 3D model for land management. The regulation is weak for registering and managing the 3D cadastre. The actual resurvey is delaying. Thus, the 3D cadastre model validation process could not be included in this study. In the future, a validation test should be performed when the cadastral resurvey is conducted.

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