Chapter 24
A Unified Building Model for a Real 3D Cadastral System

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ABSTRACT

Cadastral systems today are mostly based on digitally represented 2D parcel maps or land registries of 3D components referenced to different documents. With clear limitations to this method, this chapter focuses on creating 3D property information based on existing 3D building models. It starts by investigating shortages of the most prominent semantic building models for BIM and geospatial models (IFC and CityGML, respectively) as well as a pre-developed Unified Building Model (UBM). The result shows that neither one of the three has capabilities for complete 3D cadastre systems. The chapter proposes an extension to the UBM by adding four subtypes to the boundary surfaces above- and under-ground, namely "Building Elements," "Digging," "Protecting Area," and "Real Estate Boundary." The extended UBM is then implemented in a case study of a hospital building in Sweden and shown to be able to model all surfaces that define 3D cadastral information of buildings. The extended UBM is argued to contribute to e-planning in cities and urban applications as well as to 3D cadastral applications.

INTRODUCTION

This section provides a general background to the cadastre use and development followed by a discussion over the purpose and objectives of this study.

Background to Cadastre

A cadastre is a register of real estates in a country. It may be defined as a parcel based and up-to-date land information system that includes important records on land such as rights, ownerships and restrictions (International Federation of Surveyors, 1995). In addition to that, it usually has geometric description

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of land parcels as well as relationships to other records that describe the value of parcels, their maintenance history and development and the nature and ownerships of interests. However, in this context, the definition of Henssen (1995) was adopted as the basis for the work on CADASTRE 2014[1]. In such context, cadastre refers to public inventory of data concerning properties that are methodically arranged within a certain country or district, based on a survey of their boundaries. Such properties are systematically identified by means of outlines of the property and a parcel identifier. The outlines of the property, identifiers and the additional descriptive data may show information on each property such as the nature, size, value and legal rights or restrictions associated with the land object associated with the parcel. A cadastre is of fundamental importance to our society, since it specify the legal base of different rights of using land. Its roots can be traced back to the ancient Egypt, so it has served the societal development for a long time. During the years, the cadastre has developed to serve an increasing number of societal demands, such as the management of land and land use, legal rights, sustainable economic development and environmental planning of the city (Valstad, 2010; Van Oosterom, 2013).

The current geometric representation of cadastral information is usually based on very accurate but simple 2D representation of parcel descriptions with associated land information (Hassan, Ahmad-Nasruddin, Yaakop, & Abdul-Rahman, 2008; Stoter, Ploeger, & van Oosterom, 2013). However, in the past decade the world has witnessed an increasing amount of built-up areas as well as complexity in building construction and infrastructures, such as telecommunication networks, underground parking garages, and so on. In order to promote this development and to secure the ownership and other rights associated with these facilities, the concept of 3D cadastre has been introduced. There are clear limitations for the existing 2D systems to register and accurately define ownership and legal status that modern city development require, and make the information accessible and usable for practitioners (Karki, McDougall, & Thompson, 2010; Ledoux & Meijers, 2011; Karki, Thompson, & McDougall, 2013; Paulsson & Paasch, 2013). It is argued by Döner et al. (2011) and Stoter (2004) that for such complex structures, the creation of property rights within existing legislation does not solve the problem. There are remaining big challenges related to describing, depicting and querying the cadastre attributes in cadastral registration and applications. This actually explains the above-mentioned accurate description of FIG for the cadastral registration that considers the parcel as the basic unit where all cadastral information should be projected in 2D (see also Lemmen, van Oosterom, Uitermark, Thompson, & Hespanha, 2009; Lemmen, 2012; the Draft International Standard ISO/DIS 19152, 2011).

Following the above mentioned trends, a number of factors can be highlighted as drivers for the development of 3D cadastre:

- The part of the built environment sector that specializes in the design and construction of built facilities is rapidly converting its design and documentation systems to three dimensional building information models - BIM. The primary benefit of this new technology is the change from a simple representation (2D drawings), to a semantic representation, that allows virtual prototyping, measurement of performance and multi-disciplinary life cycle collaboration. The IFC Model specification is an open standard and exchange protocol and it is the only global open specification of intelligent building models.
- As a result of the increasing density of urban development, multi-storey buildings are increasingly having several different types of uses and new types of shared ownership.
- It is difficult on a 2D map to make simple operations like measuring the length, area, and volume of different spaces in the 3D property.

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