Chapter 7

Ontology Engineering Method for Integrating Building Models: The Case of IFC and CityGML

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ABSTRACT

The Industry Foundation Classes (IFC) and City Geography Markup Language (CityGML) are the two most prominent semantic models for the representation of Building Information Models (BIM) and geospatial objects. IFC and CityGML use different terminologies to describe the same domain, and there is a great heterogeneity in their semantics. For bidirectional conversions between these models, an intermediate Unified Building Model (UBM) is proposed that facilitates the transfer of spatial information from IFC to CityGML and vice versa. A unified model in the current study is defined as a superset model that is extended to contain all the features and objects from both IFC and CityGML building models. The conversion is a two-steps process in which a model is first converted to the unified model and then to the target model.

INTRODUCTION

As an introduction to this chapter, let us consider a crisis scenario. According to Rauschert et al. (2002) and FEMA (2003), the actions during a crisis may be classified into two types, namely crisis planning and crisis management. Before the crisis, on the one hand, different pre-event actions should be prepared and implemented. These actions (including meetings, collecting data, unifying data, building common applications, etc.) are called the crisis planning which aim at organising the work between stakeholders that may act together in case of a crises. On the other hand, during and after the crisis outbreak, the work should be managed and organised to fluently sharing information, defining roles and responsibilities, parallel updates of information,
etc.). In both phases, sharing spatial as well non-spatial data and information is a prerequisite.

During only the past five years, tens if not hundreds of natural disasters have hit our world. Considering any of them, we can clearly understand that a disaster may hit different adjacent municipalities, regions or even countries without respect to the administrative boundaries. During a disaster outbreak, crisis management systems have an important role in monitoring the affected regions and areas. Such a system should have access to the spatial data of the entire crisis area. Additionally, different datasets should be interpreted and analysed in order to determine the level of damages in each area and every single building. Considering the heterogeneity of data systems, formats, and applications, these requirements are usually not met and the problem is seen as critical for all scenarios that require cooperation in larger areas.

All stakeholders involved in a crisis require more than only sharing images and maps. Accurate analyses based on visualisation techniques, geospatial analysis and 3D modelling are also needed. This need becomes crucial when outdoor and indoor data of buildings are needed for actions like rescuing people, allocating new temporary hospitals or tracing utility networks. Interoperability means here that common understandings can be created and collaborative actions and responses can be launched.

Interoperability is seen today as one of the major challenges in the development of spatial infrastructure. It is usually related to linking different systems and organisations, by connecting large networks. Therefore, this complexity has led to different definitions of interoperability. In a general context, it is defined as the ability to exchange and use information (Groot & McLaughlin, 2000). In reality, there are big differences in systems, formats, applications, data schemas and quality of spatial data that are produced by or used by different stakeholders. This has made the direct combination of distributed spatial information from different organisations difficult if not impossible.

This book chapter is structured in the following way. The background and motivation to integrating building models are firstly described. The method for developing an integrated building model is then reviewed, specifically on how reference ontology may serve as a tool in the development of building models. Following that, the chapter deals with some theoretical concepts related to information modelling, in particular the CityGML and IFC standards. Different methods for integrating IFC and CityGML are then explained followed by description of the proposed unified building model based on reference ontology. In the last section, the results are discussed and conclusions being made.

Background to 3D City Modelling

A 3D city model is here defined as a digital representation of the Earth’s surface and the built environment within a city. Using these models, a variety of applications may be created covering the whole city or a focused specific building model. As the models become more detailed, the relationships between the spatial objects have to be modelled (Stadler & Kolbe, 2007). The 3D city models are of two types, design and real world models. While the design models are used by the Architecture, Engineering, and Construction (AEC) industry, the real world models are usually used by the geospatial information industry (mapping industry) (Pu & Zlatanova, 2006). As a result, design models are usually based on the finest available level of details of the geometric representation, while the real world models are based on the requirements from the mapping task (cost, coverage, etc.).

The current focus of today’s 3D city models is on representing geometric objects and elements types (Gröger, Kolbe, & Czerwinski, 2007). This supports the use of 3D city models only for visualisation purposes. Many GIS applications, on the other hand, use thematic queries, analysis
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