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3D Urban Information Models in making a “smart city” – the i-SCOPE project case study

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Abstract. i-SCOPE pilot project, funded by the European Commission through the CIP-ICT-PSP program, aims to develop an open source toolkit for 3D "smart city" services in three different domains: improved inclusion and personal mobility, solar energy potential assessment, noise mapping and simulation. The services are expected to improve life and work of its users. The services are built upon 3D Urban Information Models (UIM) that are based on cityGML format providing the necessary standardization and interoperability. Generation, enrichment and management of the 3D city model is a part of the i-SCOPE services. The paper shows the importance of the comprehensive and interoperable 3D city models for building the "smart city" services.

Keywords: 3D Urban Information Models, "smart city" services, i-SCOPE

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1 Introduction

There have been emerging a number of web based ICT services in urban environments aimed to change and improve different aspects of urban life. The services are designed to make cities "smarter" and are thus popularly called "smart city" services. A "smart city" can be defined as the city well performing in a forward-looking way in six characteristics, namely Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment and Smart Living, built on the "smart" combination of endowments and activities of self-decisive, independent and aware citizens [1].

A number of the "smart city" services are based on 3D spatial information. A set of the services that are being developed through an EU funded project called i-SCOPE is a good example. The i-SCOPE project is aimed to deliver an open source toolkit for 3D smart city services in three different domains:

- improved inclusion and personal mobility,
- solar energy potential assessment, and
- noise mapping and simulation.

This paper is aimed at presenting, on the i-SCOPE example, a set of the "smart city" services based on 3D UIMs and the state-of-the-art technology for 3D UIM generation and management.

2 The i-SCOPE project

According to the project's Description of Work [3], the i-SCOPE is based on interoperable 3D UIMs and delivers an open platform on the top of which it develops, within different domains, three 'smart city' services. These will be piloted and validated, within a number of EU cities which will be actively engaged throughout the project lifecycle. The services address:

1) Improved inclusion and personal mobility of aging and diversely able citizens through an accurate city-level differently-abled-friendly personal routing service which accounts for detailed urban layout, features and barriers.

2) Optimization of energy consumption through a service for accurate assessment of solar energy potential and energy loss at building level.

3) Environmental monitoring through a real-time environmental noise mapping service leveraging citizen's involvement will who act as distributed sensors city-wide measuring noise levels through their mobile phones.

i-SCOPE "smart city" services are designed to particularly address the following "smart city" characteristics and the related factors [5]:

Table 1. "Smart City" characteristics related to i-SCOPE

i-SCOPE scenario	"Smart city" characteristic	Factors
Solar potential assessment and energy efficiency of buildings (heat loss)	SMART ECONOMY	Innovative spirit Entrepreneurship
	SMART ENVIRONMENT	Environmental protection Sustainable resources management
	SMART GOVERNMENT	Political strategies and perspectives
Noise mapping and simulation	SMART ENVIRONMENT	Pollution
	SMART PEOPLE	Participation in public life
	SMART LIVING	Health conditions
	SMART GOVERNMENT	Political strategies and perspectives
Routing for diversely able citizens	SMART MOBILITY	Local accessibility
	SMART LIVING	Social cohesion

All smart services are based on already available technologies which are integrated, deployed and made publicly available from a "3D smart cities" portal.

Solar energy services enable users to find and visualise the monthly and annual irradiation maps over the whole pilot area, but also to run a detailed simulation for each roof's solar potential.

The services available in the Noise scenario are aimed to the environmental monitoring through the real-time noise mapping service, leveraging the citizens' involvement who will act as distributed sensors measuring the noise levels through their mobile phones by using the NoiseTube application. Individual noise measurements can be analysed using different criteria by authorised experts and presented as "averaged maps".

i-SCOPE smart routing service returns orientation and navigation information for pedestrians and diversely able users. The service works as classical routing services providing the instruction to arrive to the point B starting from the point A. The innovative aspect of the service is that it is focused on giving the information for the pedestrians and diversely able users. Indeed, thanks to the i-SCOPE information, the algorithm takes into account several features traditionally not used by the classical services

including: barriers, sidewalks stairs etc.

Fig. 1. i-SCOPE web client – 3D city model

Fig. 2. i-SCOPE solar potential service

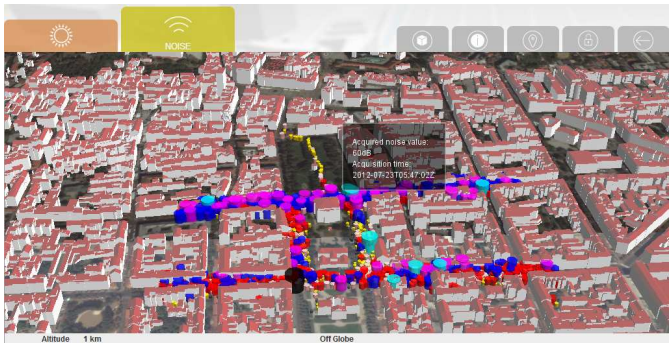

Fig. 3. i-SCOPE noise service

3 3D Urban Information Models

The i-SCOPE "smart city" services are built on the 3D Urban Information Models (UIM). In particular, the service aimed to provide the information on the solar potential at building level requires a 3D model of roofs; to calculate the best routes for mobile or visually impaired persons, information on a path slope and barriers are needed, etc. It is clear that many other potential applications can be built upon the 3D UIMs and that interoperability and standardization in creating such models are required.

In the i-SCOPE project, for building 3D UIM, cityGML, an OGC[1]standard has been used, where cityGML is defined as [2]:

"..a common information model and XML-based encoding for the representation, storage, and exchange of virtual 3D city and landscape models. CityGML provides a standard model and mechanism for describing 3D objects with respect to their geometry, topology, semantics and appearance, and defines five different levels of detail. Included are also generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. CityGML is highly scalable and datasets can include different urban entities supporting the general trend toward modeling not only individual buildings but also whole sites, districts, cities, regions, and countries."

Thematic information attached to the buildings or their features (e.g. amount of annual solar irradiation for the roof) is visualised and presented to the end-users through the i-SCOPE 3D web client. This is an example how the cityGML is used for both information generation and its cartographic representation.

3D Service Technology Platform within the i-SCOPE is based on the novaFACTORY installation [4]. The platform provides means to upload and store CityGML data in a 3D City database, to manage additional data like DTM, DSM, Floor plans, to edit CityGML, to download CityGML and to host the services like the solar energy potential assessment service. The storage of the CityGML data is handled by the 3DCityDB, an open source extension to the Oracle or PostgreSQL databases. The platform also provides the means to produce CityGML data with the help of tridicon CityModeller.

For the building generation three data sources are needed:

- Floorplans in shapefile format;
- DTM (Digital terrain model) (Text files with XYZ coordinate);
- DSM (Digital surface model) (Text files with XYZ coordinate).

[1] Open Geospatial Consortium

The process of the automated building generation with the roof recognition generates up to LOD2 CityGML buildings. novaFACTORY offers two modules for the building generation. In this project the tridicon module was used.

cityGML export jobs can be created for all the data managed by novaFACTORY. It is possible to select the criteria which data and how the data (e.g. options like format, LOD level, metadata, …) should be exported. Also additional functionality like the noise calculation or the solar potential analysis can be requested. With the help of the ps module custom scripts or programs can be started to further process the data.

The service enables also manual editing that can be of interest for the buildings which were not identified correctly or for the buildings of special interest which should be displayed in the greater detail. For the manual editing the Sketchup software is used. Therefore the 3D data has to be exported in the Sketchup file format .skp. Afterwards it can be opened and edited in the Sketchup and later on re-imported into the 3D City database.

It can be foreseen that the 3D city models, like the one described, will play an increasingly important role in our daily lives and become an essential part of the modern city Spatial Data Infrastructure [6].

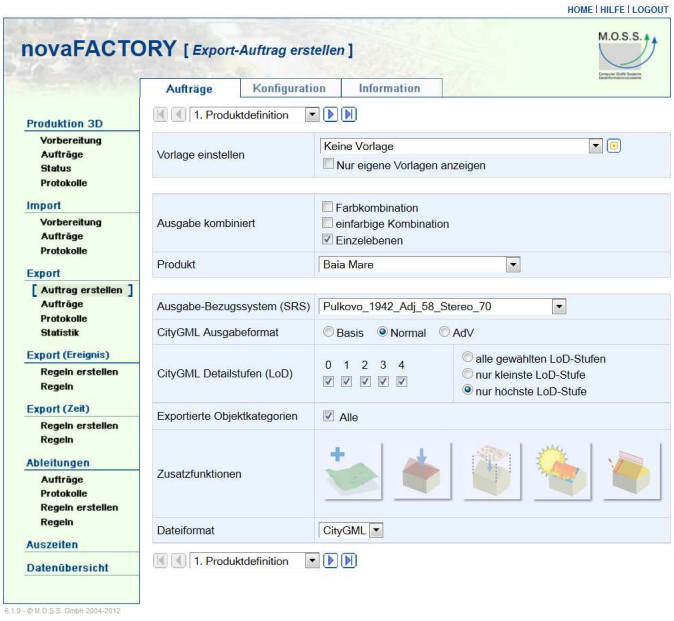

Fig. 4. novaFACTORY export GUI (taken from [4])

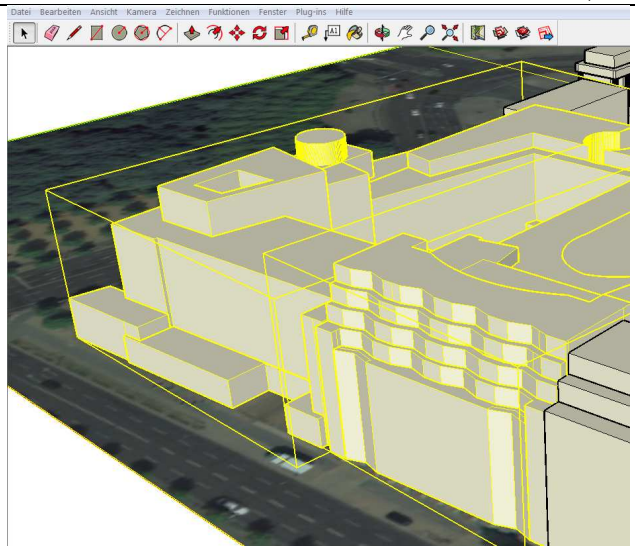

Fig. 3. Editing cityGML data in Sketchup (taken from [4])

4 Conclusion

This paper presents an example of the set of the "smart city" services built on the cityGML based 3D Urban Information Models. It shows that building the 3D city model from raw spatial data, its enrichment with additional information and management plays an important role in the services' platform. cityGML is chosen for this purpose since it is being increasingly adopted as the standard format for 3D city modelling. It also provides interoperability that further allows the other services to be built upon the same 3D city model.

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