I-SCOPE: Smart Cities and Citizens

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1 ABSTRACT

The i-SCOPE project is based on interoperable 3D Urban Information Models (UIM) and delivers an open platform on top of which it develops, within different domains, three 'smart city' services. These will be piloted and validated, within a number of EU cities that will be actively engaged throughout the project lifecycle. The services will address:

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

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

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

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

The paper explores how the different pilots are being implemented in the various cities and what is the relationship between the public administration and the end users.

2 INTRODUCTION

"Smart City" is part of the current terminology that is strictly related to the way ourdays cities perform as for livability, efficiency and sustainability, reason why it has become to goal also at EU level, such as with the Digital Agenda (2013).

The fields of application are therefore very wide and address a development of 'smarter infrastructure' on the one side and a 'smarter usage' by citizens on the other (Caragliu et al. 2011).

Among the various scopes of smart cities are the introduction of advanced mobility management solutions, dealing with both transport infrastructures and information/monitoring systems, but also services are being developed to address environmental monitoring and energy efficiency issues. This is affecting not only the energy retail market, where utilities can benefit from smart grid technologies, but also the building construction sector, where the design of low-environmental impact buildings can significantly benefit from more efficient services optimising heating, air-conditioning or power consumption.

The European Commission, within the Digital Agenda, is paying significant attention to smart cities, as technologies associated to smart cities can bring to an improved knowledge-based economy, to better social inclusion and, in more general term, to a more livable environment.

The i-SCOPE project is therefore an example of how technological solutions are being tackled, including aspects dealing with social and environmental issues. Indeed in i-SCOPE each technological solution is not considered as an achievement "per se", but it engineered following an open-innovation, user-driven approach, with the ultimate goal of promoting a so-called "humane city".

In fact the approach within the i-SCOPE can be seen as a bottom-up research process based on open innovation systems, being promoted within three key research domains: 1) inclusive routing, to facilitate personal mobility of diversely-abled citizens; 2) solar impact analysis, to promote energy savvy planning policies; 3) crowdsourced environmental monitoring, to be able to use citizens and mobile IT technologies (i.e. smartphones) as distributed sensors of environmental information.

3 TECHNOLOGY

i-SCOPE integrates open source technologies and previously developed partner projects within a comprehensive toolkit promoting interoperability through the use of OGC and other open standards for data exchange and services. This allows for independent development and functionality deployment provided by different web-services. In i-SCOPE pre-existing technologies, wherever not available as services, will be wrapped by a service layer in order to ensure compliancy with the overall schema The following diagram provides an overview of the project architecture.

i-SCOPE will significantly rely on CityGML. This is the open standard for interoperable encoding of 3D Urban Information Models. Since i-SCOPE refers to Smart Cities CityGML and its extension according to the requirements of the project is the most prominent solution. The standard is being developed by the Open Source community under coordination of OGC. As previously mentioned, i-SCOPE requires extension of the core standard as well as the creation of two Application Domain Extension (ADEs) and the extension of a third one (on noise) of the current CityGML. This will extend modelling capabilities making CityGML compliant to the requirements of the three scenarios tackled by the project:

- Sun Potential Mapping
- Noise Mapping
- Differently-abled-friendly routing

The latest generation of 3D Urban Information Models (UIM), created from accurate urban-scale geospatial information, can be used as basis to create smart web services based on geomet-ric, semantic, morphological and structural information at urban scale level. CityGML (Open-GIS 2008) represents a very attractive solution that combines 3D information and semantic in-formation in a single data model.

The aim of i-SCOPE is to deliver an open platform, based on interoperable 3D CityGML UIMs, on top of which it possible to deploy various ‘smart city’ services. The main challenge of the work is to develop into the i-SCOPE framework an effective way to exploit the CityGML potentiality to provide Smart Cities services.

CityGML is a common information model for the representation of 3D urban objects. It is realised as an open data model and XML-based format for the storage and exchange of virtual 3D city models. As an OGC standard, CityGML plays a leading role in the modularisation of urban geospatial information.

Visualisation is a complex and important issue in 3D city model applications. Efficient visualisation of 3D city models in different levels of detail (LODs) is one of the pivotal technologies to support these applications and it is fundamental to visualise the urban environment in different scales, e.g. from overview scale like a region down to detailed scale like a building or even a room. Furthermore Internet has become a basic information infrastructure all over the world even for the deployment of new smart cities technologies. Therefore, it is necessary to develop methods to visualise 3D city models through the Internet (fig.1).

Image 1: LoD1 model of Trento visualized into i_SCOPE 3D environment

I-SCOPE project implements the possible services to stream the data to the client considering two different features: a) obtain optimum performance and very short response time avoiding the complex queries that can

be made with the WFS; b) transmit to the client the geometries plus the semantic information in a single stream. The way to obtain this kind of results is to stream data directly in the CityGML format. The method consists in a downloading service, which provides to the client the CityGML data fol-lowing a classic tile-based approach fig 2. Within the iSCOPE project the client has been developed on top of Nasa World Wind java SDK. Thanks to this approach many useful features can be implemented in parallel: different services like the WMS, WFS and the proposed approach can run concurrently allowing a great flexibility of the entire system.

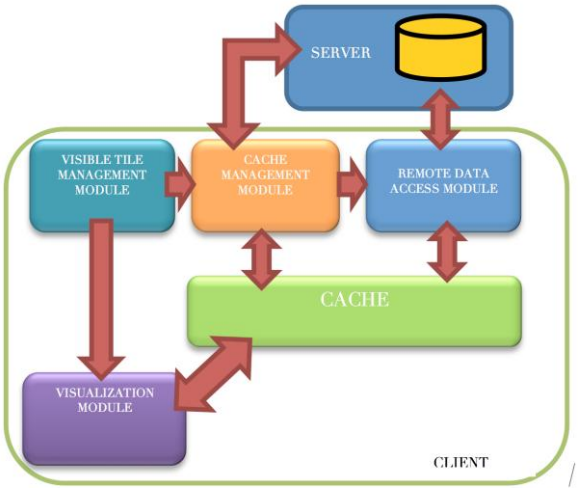

Image 2: System architecture of the proposed approach

i-SCOPE will also rely on integration of existing technologies. Specifically i-SCOPE will integrate a tool to generate 3D city models based on existing geodata data such as terrain models and floor plans to produce a realistic 3D city as CityGML. The technology will be customized and adapted to i-SCOPE's requirements in order to operate as a web service The service is asynchronous and realized with novaFACTORY software solution, the user once finished the generation can validate, both downloading and visualizing the final result, both through a summary report the quality of the model. After validation, CityGML data will be stored in 3DCityDB (2011), a free and Open Source 3D geo database to store, represent, and manage virtual 3D city models on top of the Oracle 10G R2 spatial (or 11G), developed by Institute for Geodesy and Geoinformation Science of the Berlin University of Technology.

4 THE PILOT SCENARIOS

The smart services proposed address the following three scenarios:

- Improved inclusion and personal mobility of aging people and diversely able citizens;
- Energy dispersion & solar energy potential assessment;
- Noise mapping & simulation.

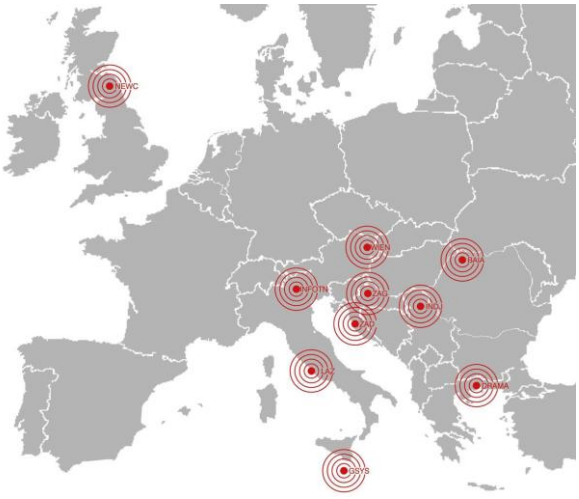

Image 3: Map of pilot cities within the i-SCOPE project

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4.1 The solar energy potential assessment

Current solar assessment GIS (e.g. ESRI Solar Analysis) calculate solar potential based on raster data that need to be created separately from existing terrain and, if available, merging building information. Other online services are simply based on the position and through manual specification of the roof layout (orientation, slope etc.).

i-SCOPE solar assessment is based on accurate 3D georeferenced models of urban environment and therefore accounts for:

- Real layout of roofs and other structures (e.g. walls, slabs etc.).
- Correct positioning.
- Shadowing effects induced by adjoining buildings as well as vegetation, infrastructures (e.g. power line posts).

Unlike other solution all the aforementioned information is automatically calculated from a high precision UIM available in the interoperable standard CityGML. In turn as output the services delivers:

- Interoperable provision of solar maps through Web Coverage Service (WCS) or Web Map Service Time (WMS-T).
- Solar simulations can be calculated through a remote service, based on interoperable standard WPS.

This way any client (including commercial or open source GIS software) can perform simulations by invoking a smart service based on an interoperable protocol.

The solar energy potential assessment involves two services:

- Irradiation calculation: computes solar irradiation raster maps for given day, latitude, surface and atmospheric conditions
- Solar energy potential calculation: requires the irradiation calculation and delivers assessment settings for the buildings

Finally we propose an innovative scenario to support the update of data on heat dispersion from community of citizens and professionals. This information can be later accessed by city administration for planning or taxation purposes. City administrations can easily create maps to show how policies have contributed to improving energy efficiency in areas of the city.

4.2 Noise mapping scenario

The second scenario that i- SCOPE focuses on is that of mapping noise in urban areas, both through a novel participatory approach involving citizens and their mobile phones, as well as through the more standard approach of simulating the most important traffic-related sources of noise in a city.

Noise pollution is a substantial problem in societies of today: a recent report of the WHO calculates that in Western-Europe only every year 1 million healthy life years are lost due to traffic-related noise exposure (WHO, 2011). As a result there is high benefit in assessing noise in urban areas, as apparent from the Environmental Noise Directive (END) imposed by the European Union (European Parliament and Council, 2002). These dictate that urban areas above a certain size – applicable to all of the pilot partners involved in i-Scope – are to produce strategic noise maps, created through computer simulations based on general statistics, such as the average number of cars in the city. These maps are backed up only by limited amounts of sound measurements, because current measuring methods are expensive and thus not very scalable. The resulting maps give an average but not at all a complete view on the situation, entirely missing local variations due to street works, neighbourhood noise etc. The NoiseTube platform proposes a solution to these issues, by facilitating sound measuring at any place and time through a mobile app that exploits basic smartphone functionalities, namely microphone, wireless connectivity and localisation through GPS. Through these three components, NoiseTube transforms already ubiquitous smartphones into highly portable, accessible sound measurement devices, thus enabling all citizens to measure ambient sound levels whenever and wherever they please. The NoiseTube website collects all user measurements and visualises them on maps. Recent research (D'Hondt & al, 2012) showed that given calibrated phones and enough measurements for a particular area, we can construct noise maps of comparable quality to those produced by

governments today, thus providing a complementary view on the noise situation of urban areas. The i-Scope project is innovative in that it covers both mapping techniques within one framework, together with several pilot actions involving city administrations.

NoiseTube is a user-friendly, free and open source tool with which citizens can estimate the quality of their daily environment and how it is affected by their behavior, providing support for awareness-building as well as for undertaking citizen- as well as city-steered actions to solve local issues. It has been used by citizens all over the world, for individual use as well as for measuring campaigns by citizen action groups.[1] With i-Scope project came the first application of NoiseTube as a top-down noise mapping campaign method steered by city administrations, with pilot activities for Zagreb (HR), Baia Mare (RO) and Trento (IT).

A noise mapping campaign is different from individual use of the NoiseTube platform in that a campaign unites a group of people in an orchestrated measurement action, typically focussing on a specific concern. Concerns can be geographical (i.e. noise issues in a neighbourhood), temporal (how do peak hours in different cities compare?) or task-oriented (your boss at city hall asks you to evaluate how street works affect the commune, or a combination of the former. In a campaign it is important that measurements are gathered in a focused way so as to increase accuracy as well as representability of maps. Concretely, the campaign in Zagreb focused on a particularly busy city trajectory during peak hours (weekdays at 8 am). Five volunteers walked this 3,5 km trajectory daily for 5 days in June 2012, jointly amassing enough measurements so that a statistically relevant dataset was obtained. The map shown below was obtained by distributing measurements over a grid and computing averages for each 20mx20m cell. Volunteers used HTC Desire C (uncalibrated) phones, while the map's colour coding adhers to the colour codes used by Croatia. Pilot activities in Trento and Baia Mare have so far been focused on individual noise trajectories rather than on aggregated campaign maps.

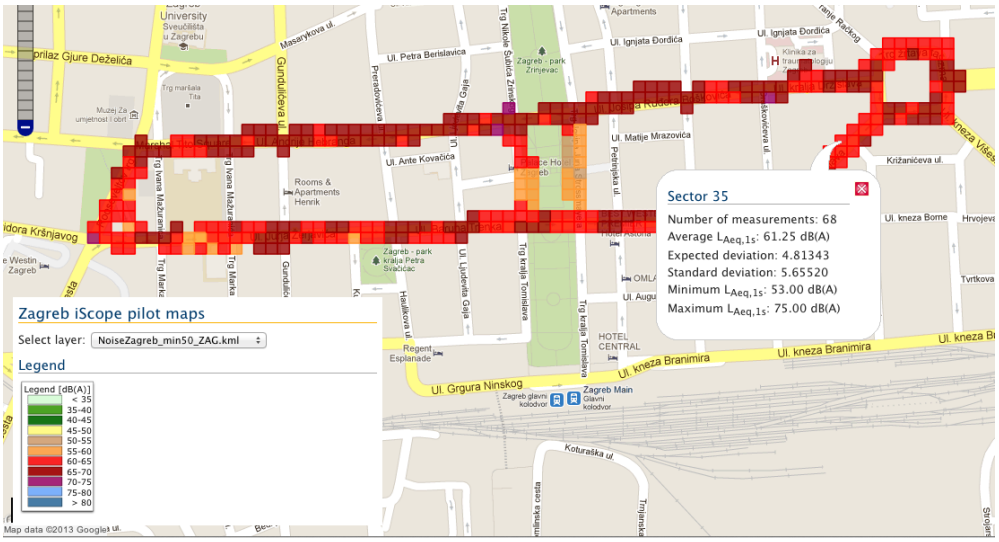

Image 4: Noise Map from the Zagreb Pilot

Our experience with city-based campaigns has been quite different from citizen-based ones. Most importantly city-based campaigns are much more centralised than grassroots ones. Indeed, the latter are more collaborative in terms of defining campaign specifications (area, time, material used). A second, related issue, is to do with communication with volunteers. Grassroots actions typically rely on a group of people already cohesive, both at the level of motivations as of concerns shared. This facilitates dissemination of NoiseTube essentials as well as communication of campaign requirements. Typically, one meeting involving a NoiseTube expert is enough to ensure a succesful campaign. In a city-based context it is often a city administrator who acts as the interface with volunteers in a hierarchical structure. Communication with the NoiseTube expert always occurred through this administrator, and never directly with the volunteers. This has led to issues with understanding campaign basics (in particular the importance of gathering enough measurements at the same tim), with motivating users to keep on measuring (by not giving them live feedback on what they had measured), and with organisation in itself. In our opinion, a well-maintained

[1] See http://www.brussense.be/experiments for interactive, aggregated maps of our noise mapping campaigns so far. Colour codes for noise maps under the END may be chosen freely by each member state.

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(ideally face2face) communication chain, either directly between an expert and the whole group of volunteers, or between expert-administrator-volunteers, is essential in delivering a succesful campaign. Since, especially in an international context, it is not always to achieve this, we are currently working towards better support for campaign definition, management and analysis within the NoiseTube framework itself.

4.3 Accessible routing scenario

The i-SCOPE project will develop inclusive routing that will be targeted for visually impaired and wheelchair users. The results of route planning can be made available for blind people as spoken instructions. Unlike route planners, the innovativeness of the application lies in the fact that the blind are guided in and at the same time have the possibility to experience and understand city spaces, streets, places, parks, etc. as spatial constructs.

The aim is to provide a holistic description of the urban space which means that the user should be able to discover as many attributes of a street section as possible to get a better image of the city. The description includes information about streets, intersections, blocks, points of interest, possible causes of risk, etc. and their spatial relation to each other. The elements of the map need to be described in a semantic way that is adapted to the requirements of pedestrians, especially blind and visually impaired ones.

How does it work?

The City portal will have the option to choose the type of user requirements needed which will be:

- Wheel chair user
- Visually impaired:
    - Blind
    - Partially sighted
    - Colour blind

In this way the user will be able to identify from where to where they need to go and receive the best path for their needs.

Additional information will be provided to the user such as Points Of Inteterest (POIs) and dangers, that var according to the need. For example wheel chair users will receive information such as the quality of the pavement or the lack of ramps, whilst visually impaired users will know what shape a crossing has, if there is a zebra crossing or if there are interesting places nearby.

The service will have the option to be used on a personal computer at home, so to prepare the route in advance, or to be used in real time via the use of a Smart Phone (Android).

The added value of a mobile service is that in case of any unforeseen changes due to road works or changes in plans, the user will still be able to receive an ad hoc route. It must be said though that most users still will be preparing their route at home as this makes them often feel more secure.

The i-SCOPE accessible routing service will not be an alternative to other devices such as a guide dog or a cane, but it will be an additional aid that can provide great benefit.

4.4 The experience of the City of Vienna

In occasion of the Wiener Charta talks, a series of events held within the Local Agenda 21 activities of the city of Vienna where citizens define issues that the City Adminstration should tackle, a discussion on urban accessibility was held and the i-SCOPE project was discussed with the various user groups.

The half day workshop had representatives from the City of Vienna, Companies and research institutions involved in the development of accessible technologies and the user groups, respectively the visually impaired associations and the wheel chair users.

There was a presentation of the i-SCOPE project and then an interactive and lively debate where many issues were tackled, from broader comments such as the fact that accessibility is related to an overall societal attitude to more specific issues such as the affordability of accessible technologies.

What was interesting was that various stakeholders sitting round the table had the possibility to express needs and requirements yet at the same time provide comments and possible solutions to the other.

The event was considered very useful and it was agreed that other events like this will take place again, also out of the Wiener Charta context, also in view of the upcoming testing phase of the i-SCOPE prototype.

In this sense all the participants decided that the idea of starting up an ongoin platform to discuss about innovations within the city would be very useful, reason why the idea of becoming a Living Lab was received with great interest.

In fact the city of Vienna in the coming years will get more and more involved in the Living Lab network in order to bring together public administration, companies and citizens on a regular basis.

5 CONSIDERATIONS ON THE RELATIONSHIP BETWEEN CITIES AND CITIZENS

Citizens' involvement in the i-SCOPE project is an essential strategic element that allows demonstration of the use of the smart services that will be developed during the project implementation and thus to give assurance to the stakeholders of the investment's value . The citizens are one of the most important final users of the services that are going to be developed. Part of the project's sustainability is connected to the capability of local administrations (pilot partner cities/regions) to convey citizens' interest towards the platform/smart toolkit services and to involve them firstly as users but even as co-designer of/for smart solutions that are to be developed. Not only that the main results are directed to them, but also they are involved in the entire process of creating and achieving the necessary data for the project. Moreover, they are involved in the testing of the smart services that are to be created.

Also when thinking about citizens' involvement, it is important to consider that addressing citizens means not only addressing specific categories of stakeholders (e.g. cultural, environmental, economic grassroots organizations), but also to address citizenship in its various expressions (e.g. citizen as politicians, civil servants, city users, teachers and apprentices…). In fully experiencing citizenship rights, people (inhabitants) change roles different times. It is for these reasons that i-SCOPE is increasing citizens' awareness using direct (seminars, workshops, lectures…), semi-indirect (web communication, social networking…), and indirect (press releases, brochures, scientific articles…) means. Indeed, i-SCOPE partners are proceeding using all these communication possibilities.

Finally, it can be stated that the citizen's involvement takes place in 3 key phases:

(1) General information and publicity of the project to the citizens and relevant actors.

(2) General presentation of the stage of the project (evolution), initiated actions, finalized action, first results, and permanent dialog with the citizens and feedback selection from the citizens. Involvement of the citizens in the improving of the prototypes (using a careful predefined methodology). Periodic testing of the prototypes and products.

(3) General presentation of the implemented project (all actions implemented). Dissemination of the final results. Implementation of the prototypes. Future ideas for the improvement of the products

6 CONCLUSIONS

The many i-SCOPE outputs, from the more technological ones to the definition of indicators and frames for policies, will fall on different categories (from meta data modelling, definition of platform to the design of services and urban/territorial policies) that cannot bring to a synthesis if not faced in the context of a pluralistic and multi-faced governance based on the directive and directions given by the EU. The questions connected to inter-regional/cross border use of data, those connected to the indications for the design of trans-national services (the market is definitively global), the other linked with the indication to provide for the design of policies and strategies (the EU should provide a soft creation of coherence among all national and local policies in order to avoid unbalances in use of funds and in the definition of policy principles) are just few examples that demonstrate how the i-SCOPE purposes cannot be solved at local or at national level, but required to be set up, experimented and implemented at EU scale through the implementation of a partnership including, public administration (cities and regions) SMEs and research centres.

7 ACKNOWLEDGMENTS

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