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Wikicity: Real-Time Location-Sensitive Tools for the City

keywords real-time city, location based service, urban dynamics, control system

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People moving and acting in a city base their decisions on information that is in most cases not synchronized with the time and place they find themselves in when taking that decision. How often have you arrived at the airport just to find out that your flight has been delayed, been surprised by a traffic jam, found that a product is out of stock or a service operator busy at the moment you needed it.

In the same way, a person acting in a city contributes herself to dynamics of which others are not aware of when making their decisions. Looked upon in this way a city resembles what Deleuze and Guattari describe as a "rhizome" (Deleuze & Guattari, 1977). The rhizome is a philosophical network structure where every part is necessarily connected with every other part of the system. There are no preferential connections because every connection alters the overall network structure. As a consequence, the rhizome can not be plotted since the plotting action itself is part of the rhizome and thus in the very moment of plotting its structure, the structure changes.

The WikiCity project, in a similar way, is concerned with the real-time mapping of city dynamics. This mapping however is not limited to representing the city but instead becomes instantly an instrument for city inhabitants to base their actions and decisions upon in a better informed manner. In this way the real-time map changes the city context as well as that altered context changes the real-time map accordingly. This with the ultimate aim of leading to an overall increased efficiency and sustainability in making use of the city environment.

In order to identify the functional elements needed to construct such an instrument we chose the real-time control system as an analogy to start with. In the past decades, real time control systems have been developed for, and deployed, in a variety of engineering applications. In so doing, they have dramatically increased the efficiency of systems through energy savings, self-organization/repair, regulation of the dynamics, increased robustness and disturbance tolerance.

A concrete challenge we aim to tackle in this paper is applying the real-time control

theory and practice to cities in order to reduce the inefficiencies of present day urban systems and open the way to a more sustainable urban future. So in this paper we try to understand whether a city can be effectively modeled and controlled in real-time as a Cyber Physical System.

Let's examine the four key components of a real time control system:

1. entity to be controlled in an environment characterized by uncertainty;
2. sensors able to acquire information about the entity's state in real time;
3. intelligence capable of evaluating system performance against desired outcomes;
4. physical actuators able to act upon the system to realize the control strategy.

A city certainly fits the definition of point 1. Point 2 does not seem to pose particular problems: today's deployment of a range of remote sensors in urban areas allows for unprecedented data collection and analysis. As an example, the Real Time Rome project[1] developed a unique approach to real-time urban monitoring, based on the use of anonymous real-time data gathered from cellular phones and GPS devices. The project was able to collect the movement patterns of people and transportation systems, and their spatial and social usage of streets and neighborhoods. Information regarding further aspects are already collected continuously by distinct computing systems that track product and service availability, environmental values, climatic conditions, acoustic values, events,…

What about points 3 and 4? How to actuate the city? Although the city already contains several classes of actuators such as traffic lights and remotely updated street signage, their range of use is currently limited. A much more flexible actuator would be the city's own inhabitants: they represent a distributed actuation system in which each person pursues his individual interest in cooperation and competition with others, with the overall behavior of the system governed by the interaction between individuals. People can also clearly form part of the overall intelligence of the control system.

Towards the above goal, the WikiCity project can be thought of as adding further, interaction-oriented layers to a real-time map of the city and making location and time-sensitive information accessible to users, allowing them full control on the database, onto which they can upload and download data.

This paper will present a new platform for storing and exchanging data which are location and time-sensitive, making them accessible to users through mobile devices, web interfaces and physical interface objects. This platform enables people to become distributed intelligent actuators and thus prime actors themselves in improving the efficiency of urban systems.

The system is based on a common, semantically defined, format for interchange of locational data and a distributed platform able to collect and manage such data in real time. The latest W3C trends, including Semantic Web (Berners-Lee, Hendler, Lassila, 2001) and Web Services Composition (BPEL4WS, 2007), provide the basis for developing and maintaining such platform.

By deploying developments of the 'Web 2.0' and the 'Semantic Web' WikiCity can be

[1] Real Time Rome is a partnership project between the MIT SENSEable City Laboratory and Telecom Italia that was presented at the Venice Biennale of Architecture, 2006, http://senseable.mit.edu/realtimerome/ (see Calabrese & Ratti, 2006).

a significant leap forward towards a pervasive ‘internet of things’ (ITS, 2005) to support human action and interaction.

WikiCity is a work in progress. Attention during the coming months will be driven onto three main areas: Concepts and scenarios, System structure and implementation, Interface modality. A brief description of these research topics is given in the following, while detailed description of the developed work will be presented in the full paper.

Concepts and scenarios

WikiCity is about envisioning new application scenarios on the basis of a technology potential involved in location and time-sensitive information. As an instrument for developing applications for this new technology system we are systematically analyzing intersections between needs and opportunities of three element groups which we have identified and which are Agents, Environment and Technology features.

On the basis of these analysis user scenario and storyboard creating will be instrumental for guiding on the one hand the technical implementation of the hard- and software and on the other to make best use of this very implementation.

System structure and implementation

The WikiCity project aims at adapting a common format for interchange of real-time location-based data and a distributed platform able to collect, manage and provide such data in real time. In this way the city’s most informative real-time map can be created, letting users broadcast their location and have site-specific information pushed on them per request. WikiCity can be divided into a number of manageable channels (layers) like mobility, events, aggregate information, and whatever is most useful and efficient for users to search and access the geospatial content they’re looking for.

Instead of starting the implementation of the project by a top-down approach such as the definition of standards we consider a bottom-up approach in terms of a case study that allows for experimenting with the platform. For the development of WikiCity a city will be chosen whose local authority becomes a key partner and active agent in the entire process which then is open to and involves potentially all city inhabitants and businesses in the given metropolitan area.

We aim at acquiring data from:

1. telecom operators, such as aggregate mobile phones location data and further users information;
2. public transport (bus, subway, train), such as vehicles' locations, paths and time schedules;
3. companies, which have real-time location information of a number of vehicles (e.g. car fleet management, taxi,…);
4. businesses, which want to provide services/products that are location-time sensitive;
5. local authorities, that can add information about upcoming events, activities or environmental conditions.
6. any private individual, that can upload information on general interest, on events, about requests or offerings.

We have also identified a software architecture for the development of WikiCity, composed of six main components:

1. Data authoring;
2. Data acquisition;
3. Data storage infrastructure;
4. Metadata engine;
5. Data extraction and processing;
6. User interface.

Interface modality

Just as important as the information is, that can be presented in various circumstances in relation to a city map, the very way the information is made accessible determines the effective outcome and relevant acceptance of the project as such. For this reason WikiCity explores different interface modalities that create connections between the virtual data and the actual physical world where these data is accessed by users. Interfaces to WikiCity can be more closely positioned to the built environment in terms of interior spaces (Desktop PC, Wall projections,...) and or outdoor spaces (info totem, facade display,...), they can be linked to moving vehicles (public transportation, car infotainment centre,...) or they can be closely located to the user himself (Smartphone, PDA, PC Laptop,...).

Keywords: real-time city, location based service, urban dynamics, control system.

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Francesco Calabrese graduated in Informatics Engineering, cum laude, from the University of Naples Federico II, Italy, in February 2004. He is currently a Ph.D. student in Informatics and Automatics Engineering at the Department of Computer and Systems Engineering of the University of Naples Federico II, Italy, and a Visiting Ph.D. student at the SENSEable City Laboratory of the Massachusetts Institute of Technology, Cambridge, MA, USA, with a Tronchetti Provera fellowship, awarded by the Italy-MIT Consortium. His research interests include hybrids control systems, embedded control systems, CNC machines, real-time control systems, real-time analysis of telecom systems and urban dynamics.

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After having attended Architecture and Industrial Design degree courses in Austria, England and Italy, Kristian Kloeckl graduated at the Politecnico di Milano, Italy, with distinction. He is currently enrolled in the Design Science PhD program at the Iuav University of Venice, Italy, and a Visiting Ph.D. student at the SENSEable City Laboratory of the Massachusetts Institute of Technology, Cambridge, MA, USA. His research interests have covered areas such as product design in the urban context, medical design and connections design while he is also holding design classes in various institutes.

Besides his academic work he has been collaborating with leading design studios in Berlin and Milan before setting up his own design practice in 2003 in Venice.

Carlo Ratti

An architect and engineer by education, Carlo Ratti is Associate Professor of the Practice of Urban Technologies at the Massachusetts Institute of Technology, where he directs the SENSEable City Laboratory. The SENSEable City Laboratory is a new research initiative that explores how technology is transforming urban design and living; in less than three years it has set up several industrial partnerships and has claimed a number of patents. Carlo is also founding partner and director of carlorattiassociati, a rapidly growing architectural practice that was established in Turin, Italy, in 2002; the practice is currently involved in a number of architectural schemes, both nationally and internationally. Carlo graduated in structural engineering from the Politecnico di Torino and the Ecole Nationale des Ponts et Chaussies, later specializing in architecture with MPhil and PhD degrees from the University of Cambridge. He is a member of several professional organizations, including the Ordine degli Ingegneri di Torino, the Association des Anciens Eleves de l'Ecole Nationale des Ponts et Chaussees and the UK Architects Registration Board.

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