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## Editorial

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**Biographical notes:** Irene Mavrommati is an Assistant Professor at the Hellenic Open University, School of Applied Arts. She cooperates with CTI as an interaction designer/researcher (since 2000), and has previously been with Philips Design, the Netherlands as a senior interaction designer/project manager. She has extensive experience in design and research, focusing in Aml systems' interaction, has led several EU FET research projects, and was a member of the Disappearing Computer Steering Group. She holds a PhD in Interaction Design from the Dept. of Products and Systems Design Engineering, University of the Aegean, an MA in Interactive Multimedia (RCA) and an MA and BA in Graphic Design.

Ioannis Chatzigiannakis holds a PhD from the University of Patras (2003) and a BEng from the University of Kent (1997). He is an Associate Professor at the La Sapienza University of Rome at the Department of Computer, Control and Management Engineering (DIAG). He has co-authored over 110 scientific publications in areas related to distributed and mobile computing, internet of things and algorithm engineering. He was a senior researcher in more than ten EU funded R&D projects in the areas of internet of things, distributed systems and the future internet. He is the Secretary of the European Association for Theoretical Computer Science (EATCS).

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This special issue features eight articles on hybrid environments and the real-world internet. The introduction describes the motivation for the special issue and briefly overviews the contributions. All articles work towards the realisation of smart cities by exploiting real-world internet technologies and employ experimentally driven research to evaluate their findings and show that they are both practical and effective.

Cities are the focal point of European economy, as more than 70% of the European population lives and works in cities. During the last years, significant efforts have been made to improve the living quality and develop new economic activities of European

cities. These efforts rely on new ICT infrastructures that enable the operation of advanced services in several areas of interest, ranging from multimodal personal mobility and energy consumption, to social networking and e-government, thus transforming the cities into smart cities.

The domain of smart cities is currently burgeoning, with a lot of potential for scientific and socio-economic innovation gradually being revealed. It is also becoming apparent that cross-discipline research will be instrumental in designing and building smarter cities, where IoT technology is becoming omnipresent. The first article of the special issue, titled ‘Developments and challenges ahead in smart city frameworks – lessons from SmartSantander’, presents the SmartSantander project that built a massive city-scale IoT testbed, providing both a tool for the research community and a functional system for the local government to implement operational city services. The article presents key smart cities projects, main application domains and representative smart city frameworks that reflect the latest advances in the smart cities domain. The authors identify and discuss a number of key scientific and technological challenges. They look into the SmartSantander testbed facility, present an overview of the developed system components and applications, and discuss the ways that current smart city challenges were handled in the project.

A characteristic challenge of smart cities research is the fact that smart city applications have to be driven by citizens’ needs. The human element must not be underestimated, because the success of a smart city ecosystem, even if it is technologically perfect, relies on the societal acceptance. Citizens’ expectations for interacting with and gaining access to smart city services are rapidly changing. On one hand, the youngsters expect to become more and more socially connected, while the older people mainly demand for e-health services. In both cases, smart city applications have to be built around people, answering to their complex and personalised demands and giving them the proper motivation to actively participate in the smart city ecosystem. Feedback from citizens’ usage of smart city services is the most important issue to be tackled to raise citizen awareness and acceptance of innovative and exciting smart city services. Thus, there is a need for a well-defined citizen engagement strategy to foster the use of smart city exciting new services. Citizens must be the lens through which smart city plan (deployment, development and operation) will be built upon.

Towards addressing this core challenge, the second article ‘Evaluating the user experience of a mobile user in a smart city context’ presents the results of the user experience evaluation of an innovative intelligent transport application, ultimately aiming at enhancing the user experience of an advanced transportation services platform. The application was evaluated in SmartSantander, the leading real-world smart city facility developed under the support of FP7 framework and within the future internet research and experimentation (FIRE) initiative. The evaluation aimed to serve as a step toward exploring the way in which elements of the system design affect the user experience in terms of functionality, utility, usability, performance and emotional impact.

The third article ‘Field experience and user evaluation from a real-world internet application in an urban-scale environment’ presents the experience acquired and the evaluation results that were collected while applying a real-world internet application in an urban-scale environment. The article presents the design principles of the application, its deployment exploiting various interfaces in varied urban environments and the experience gathered performing field trials and collecting user evaluation in the physical landscape of a city over the long run. The article focuses on elaborating and exploiting

diverse interfaces, starting from a domestic setting and then moving to urban scale, how users perceive them, on the blending of digital layers of content with the physical landscape, and on how a real-world internet application can foster social interactions.

The next article titled ‘Extracting game design patterns from game design workshops’ studies the design of hybrid reality location-based mobile games. They are played in a hybrid environment, in part by players’ actions in the physical space and in part by actions and events in an interconnected digital space. The article presents the organisation of workshops involving designers and end-users for the generation of novel game concepts. The resulting design patterns are intended not as components that can be combined in a mechanistic way in order to generate a game design, but are to be viewed as design elements that can support ideation and concept generation.

The fifth article titled ‘A ubiquitous recommender system based on collaborative filtering and social networking data’ studies the usage of mobile devices as a ubiquitous recommender systems to collect feedback from users in smart cities environments and looks into different factors that need to be considered in order to get more useful recommendations and increase the quality of the user experience. The article proposes a new hybrid recommendation model that is based on collaborative filtering and social rating network data. Furthermore, it includes an approach to protect user privacy when context parameters are used, by transferring a subset of the users and ratings in the mobile device and applying the algorithm and context parameters locally. User-based collaborative filtering is suggested, enhanced by the trust network, as a method that performs better in terms of accuracy when compared with user-based collaborative filtering and trust-aware collaborative filtering.

The next three articles look into technological as well as conceptual barriers for realising smart cities. They work on the observation that the majority of the smart city efforts so far were conducted in isolation, deploying purpose specific ICT infrastructures thus increasing the costs of installation and maintenance and inevitably limiting, to a large extent, the overall impact. As a result of the proliferating smart city deployments in different sectors (such as energy, transport, and e-government), most cities have nowadays to manage/deal with multiple vertical smart city deployments and applications. In most cases, these applications have been designed and developed independently from each other, even when they have been deployed as part of a unified strategic plan. In this perspective, interoperability is a major drawback towards a city-wide infrastructure and service integration. Furthermore, the various applications tend to evolve independently of each other, given that updates and enhancements to existing smart city applications rely on heterogeneous platforms and architectures. Finally, management issues have to be resolved, ranging from bureaucratic attitude of some local governmental departments to unwillingness of stakeholders to share data.

The article ‘Resource and service virtualisation in M2M and IoT platforms’ presents a novel platform that decouples hardware, software and service provisioning through principles of virtualisation has enabled the exponential uptake of today’s internet. It introduces beyond state-of-the-art technological advancements following the recent standardisation efforts in this research area.

The article ‘Extending TETRA with wireless sensor networks’ looks into a well established system, an open standard developed by ETSI and designed to support mobile radio communications in a number of market segments, among which public safety is by far the largest one. It presents the design of specific architectural extensions of the

terrestrial trunked radio system to integrate wireless sensor networks that are a crucial component for the realisation of smart cities. The paper looks into two specific smart city application scenarios that are relevant in public safety scenarios: structural health monitoring and air quality monitoring.

The article 'Issues on visual representation of hybrid home environments: survey of strategies and models' works based on the key observation that future smart environments will incorporate enormous numbers of heterogeneous smart devices and objects, communicating over different wireless standards, continuously exchanging information with external sources, that inevitably undermines the inhabitants' ability to perceive the smart environments in their totality. The article elaborates on possible and appropriate ways to represent visually these complex relations by providing a better understanding of the structure, form and perplexity of an augmented smart environment.

The solutions and applications discussed here are characterised by the involvement of different disciplines and bridge several research perspectives. We hope that this special issue will provide readers an overview of several of the issues raised by the use of smart objects, and the possibilities for services and applications within the context of the surrounding environment.

Last but not least, this issue would not have been possible without the reviewer's diligent feedback, for which we are deeply indebted, and the effectiveness of the Editor-in-Chief Professor Ahmad Taher Azar, Faculty of Computers and Information, Benha University, Egypt. We would like to thank them all for their efforts in realising this issue.