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IoT for Energy-Efficiency: connecting a serious game with energy metering in the EnerGAware project

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Abstract

The Internet of Things (IoT) emerged with the potential to change our daily lives and the way we interact and operate with our environment. However, in practice, IoT mixes a multitude of devices and subsystems, which are required to work together to provide the user with the expected quality of service. This leads to considerable development challenges, which are exacerbated by the speed of development and heterogeneity of IoT devices. This communication describes an IoT solution being implemented in the setting of a serious game application, connected to real homes energy consumption. The solution follows a publish-subscribe architecture to decouple the components of the system.

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The Internet of Things (IoT) emerged with the potential to change our daily lives and the way we interact and operate with our environment. However, in practice, IoT mixes a multitude of devices and subsystems, which are required to work together to provide the user with the expected quality of service. This leads to considerable development challenges, which are exacerbated by the speed of development and heterogeneity of IoT devices. This communication describes an IoT solution being implemented in the setting of a serious game application, connected to real homes energy consumption. The solution follows a publish-subscribe architecture to decouple the components of the system.

1 Introduction

The Internet of Things (IoT) is transforming the world we live, providing highly dense, heterogeneous and complex computing systems, which are able to sense and actuate our environment, connecting it with the virtual world at our fingertips, on our computers or smartphones.

This pervasiveness is being pushed both by technological advances, which allow cheap and widespread IoT devices, and by increasing user demand for additional services. Although with several advantages, this trend is leading to a multitude of systems being deployed, most of the times using incompatible technologies and communication systems.

The heterogeneity and fast moving nature of IoT devices and systems, makes it very difficult to develop and efficiently deploy these systems. Providing value requires that systems integrate seamlessly, with an easy and quick access to the end user, most of the times a non-expert on technology. This is more and more important in several application domains, even more in those targeting the general public, such as home energy-efficiency systems and applications. It is thus fundamental that systems are able to be easily interconnected, and coupling of components reduced to the required minimum.

2 The EnerGAware project

The EnerGAware project [1,2] is an European project whose goal is to promote energy efficiency by the use of a serious online game to enhance users' behavioural change through education and training. This follows from results that point out the effectiveness of serious games in domestic energy consumption [3], which concluded that gamification and serious game can be of value for energy consumption, conservation and efficiency. The project addresses existing houses, as the building sector currently accounts for 40% of energy use in most countries [4] and has the greatest energy saving potential [5]. As a consequence, the cornerstone of the European energy policy has an explicit orientation to the conservation and rational use of energy in buildings [6]. As buildings tend to have long lifetimes, to achieve significant impact in the short- and medium-term the challenge must be focused on the existing buildings.

The project has deployed a real-life conditions pilot in a set of houses located in Plymouth (United Kingdom). The energy consumption of houses, as well as the awareness, attitudes, engagement and self-reported behaviours of the tenants are being assessed both before and after the implementation of the serious game (preliminary results show a daily electricity saving ranging from 3 to 10% [1]). Once the project is finished, it will provide more quantitative empirical research on the effectiveness of serious games within the domain of domestic energy reduction.

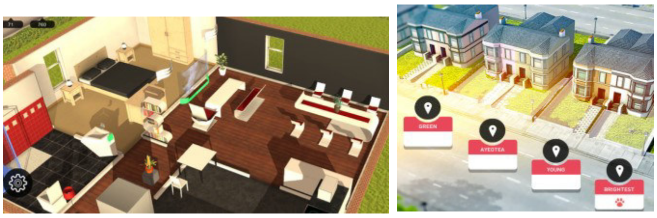

Figure 1 – Game scenarios.

The serious game [7] is based on pseudo-realistic scenarios (Figure 1); the requirements analysis phase [8] and focus groups concluded that this would be better than a fantasy world (or sci-fi, or cartoon) and better than a fully-realistic simulation. The pilot includes energy (electricity and gas consumption) monitoring through an infrastructure installed in the homes, allowing the game to display to the user real energy savings (weighted according to the climate severity). Players making real energy savings receive rewards in the game.

The monitoring infrastructure uses a proprietary communication system, being the data available through a specific server (Concordia [9]). Considering that the energy consumption is related to the weather conditions, daily weather parameters, especially air temperature, are also retrieved from a weather platform. The project goals also included the development of an IoT based infrastructure to interconnect the different components of the system.

3 The EnerGAware Middleware

To connect all systems, and aggregate and distribute all the data (energy consumption, weather and game experience), an IoT middleware was designed (Figure 2). The Middleware is built upon a FIWARE platform [10], using Web of Things technologies providing generic and flexible REST-based APIs with messages based on URIs/URLs (as web services) [11]. This allows that a small number of generic methods can create a consistent, interoperable API [12].

With respect to service management, the middleware considers an architecture consisting of a set of interconnected components which may be co-located and/or distributed over a network of communicating computer nodes. The approach tackles the limitation of Service Oriented Architectures (SOA) using a Publish-Subscribe approach, removing the strong coupling of the client/server paradigm [13].

Although the middleware was specified and built for the purpose of the project, it was designed to be generic and support a multitude of house devices, and multiple applications or games, being also scalable in terms of load. This communication will provide a technical overview of the main components of this middleware and how it is being used in the scope of the EnerGAware pilot.

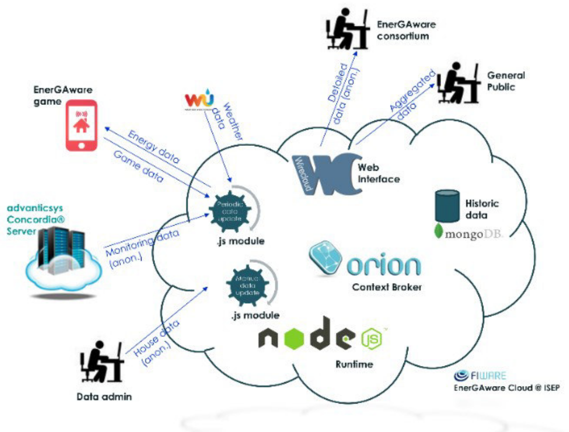

Figure 2 – System Architecture.

4 Conclusions

This communication provides an overview of the solution developed in the EnerGAware European project, to interconnect a serious game with an energy monitoring systems. The solution was implemented for this specific application, but it was designed to be generic, based on the FIWARE concept, for easy extension and scalability. The goal is to allow reducing the complexity and development effort of the Internet of Things.

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