Chapter 35
Developing Context-Aware Personal Smart Spaces

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ABSTRACT

Current research on pervasive computing is opening the way for convergence between mobile telecommunications and the Future Internet. This chapter introduces a novel approach to this convergence in the form of the self-improving Personal Smart Spaces (PSSs). PSSs aim to couple the facilities offered by next generation mobile communications with the features provided by the static smart spaces to support a more ubiquitous, context-aware and personalised smart space that is able to follow the user wherever he/she goes. Moreover, PSSs provide interfaces between the user and the various services and sensors which are, or will be, available via the Internet. In this respect, one of the core aspects that need to be supported within PSSs is the management of the user related context information. This chapter elaborates on the models and mechanisms that have been designed and implemented in order to address the advanced requirements of PSSs regarding the establishment of a robust distributed context management framework.

INTRODUCTION

Pervasive computing (Saha & Mukherjee, 2003; Satyanarayanan, 2001; Schmidt et al., 2006) is a next generation system paradigm that aims to assist users in their everyday tasks in a seamless unobtrusive manner. It assumes that users are surrounded by numerous communication and computing devices of various features, which interoperate and are capable of capturing and processing information regarding users, their behaviour and their environments. In this framework, there have been various research initiatives aiming towards the design and realisation of smart spaces

DOI: 10.4018/978-1-61520-655-1.ch035

(Singh et al., 2006) in homes, offices, universities, schools, hospitals, hotels, museums, and other private or public places, where various automation facilities support the users. In these cases, research has focused on developing techniques to support building automation (such as intelligent light controls, window shutters, security systems, electrical appliances, door control, etc.), as well as mechanisms to adapt the behaviour of electronic devices (such as TV, radio and multimedia players), desktops and peripherals, etc. Nevertheless, these are fixed spaces that provide pervasive features and adapt to the user needs in a static and geographically limited environment.

Nevertheless, when dealing with mobile users, different and more challenging problems are introduced and need to be resolved (Hansmann et al., 2003; Huang & Mangs, 2008). In this case, the users require the same pervasive services wherever they are and whatever devices they carry along. Irrespective of the user's location, such a mobile pervasive system would be expected to provide access to devices and services in the user's current environment. For instance, if the user wishes to access a telephone service, the system might select a fixed line telephone if the user is at home, the user's mobile phone if the user is walking on the street, the user's car computer system if the user is in a car, and so on. Likewise, a user's location might be used to select different network options and services when the user is at home from when he/she is at the office.

These fixed smart spaces are alike independent "islands" of pervasiveness in a sea of legacy service provisioning systems. When the users exit these "islands" limited pervasive computing features are offered. For example, a Smart Home may control the devices within it and the services it offers to its residents, but it cannot easily share these with the mobile network of any visitor. A typical use case is that of personal biometric sensors that could potentially communicate with controls for illumination, heating or air conditioning in a room to provide the ideal environment for a user or the best compromise for a group of users. To bridge this gap, the notion of self-improving Personal Smart Spaces has been introduced (Roussaki et al., 2008).

Personal Smart Spaces (PSSs) aim to couple the facilities offered by next generation mobile communications with the features provided by the static smart spaces to support a more ubiquitous and personalised smart space that is able to follow the user wherever he/she goes. A PSS will provide to its owner multimodal intelligent interfaces, via which he/she will be able to access and configure the various services and resources that are available locally and remotely, even when limited or even no network connectivity is available. PSSs will be able to discover other PSSs and interact with them in order to create a richer and more flexible environment for their owners. Each PSS consists of multiple devices, both mobile and fixed, owned by a single user. As the owner of the PSS moves to different locations and places, his/her PSS interact with other mobile or fixed PSSs located in the owner's surrounding environment, aiming for a unique support for pervasive service provisioning. PSSs constantly monitor their owner's behaviour & environment and they exploit learning techniques to further optimise the pervasive experience perceived by their owners. In a nutshell, a Personal Smart Space can be defined as a set of services within a dynamic space of connectable devices, where the set of services are owned, controlled, or administered by a single user. It facilitates interactions with other PSSs, it is self-improving and is capable of proactive behaviour. Thus, a PSS is user centric and controlled by a single user, it is mobile (at least from user perspective), it allows interactions with other PSSs and is capable of self-improvement and pro-activity.

In PSSs, network operators, individual sensors, sensor networks or even web and computing resource managers capture valuable information (e.g. device location/status, user profiles, movement patterns, user activities, network