Chapter 4

A Multi-User Ad-Hoc Resource Manager for Public Urban Areas

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ABSTRACT

Smart spaces are defined as an environment capable of communicating with users in order to support them in achieving a goal. Previously, smart spaces were restricted to closed private areas in a well-defined environment. However, factors such as the omnipresence of mobile devices, the advancement in wireless communication, and the low cost of technological infrastructure allows the creation of smart spaces everywhere. One trend that is acquiring relevance these days is to use surrounding public resources to perform tasks on behalf of mobile devices, which are resource constrained. To achieve this, systems should be able to control the access to public resources, minimize possible interference among users, and maintain the purpose of public resources untouched. This work presents a multi-user ad-hoc resource manager for smart urban areas based on previous considerations. The current system helps to avoid conflicts between users by means of a distributed scheme based on social gain for the community. The management is performed without the need of a central infrastructure. Results show that it is possible to discover and manage public resources from mobile devices while handling conflicts in a distributed manner.

INTRODUCTION

Urban Computing is defined as ‘the integration of computing, sensing, and actuation technologies into every-day urban settings and lifestyles. Those settings include, for example, streets, squares, pubs, shops, buses, and cafes - any space in the semi-public realms of our towns and cities’ (Kindberg, Chalmers, & Paulos, 2007). It emerges as a response to limitations of ubiquitous computing, such as recognition of city areas as locations instead of spaces; lack of multiple users and their social relationships considerations; interaction between multiple people, smart objects, environment; among other. In order to resolve these limitations, urban computing goes one step further to understand form, meaning of spaces based on residents, applications; incorporate social relation-
ships of coexisting people and smart objects and achieve an ecological coexistence of people and smart objects in a given space.

One of the main goals of urban computing is the creation of an open computing infrastructure in the city. The advancement in the development of mobile devices and wireless networks means that users can access them anytime, anywhere, creating smart spaces on the fly. But mobile devices are still limited in resources. Therefore, by surrounding the user with this open infrastructure, users can perform tasks that are not possible (or not pleasant) to execute relying solely on their mobile devices. Hence, users can execute remote tasks in three different ways: by accessing public resources available at the surroundings; by using the underlying network and computing infrastructure; or by obtaining resources from the nearby users. An example of such provision is the Internet Suspend and Resume (ISR) work (Smaldone, Gilbert, Toups, Ifode, & Satyanarayanan, 2008). In this work, authors take advantage of surrounding displays and computers to run a virtual machine containing a copy of my desktop, enabling users to resume their work anywhere. Another alternative is to offload tasks that are not possible to run or consume a high level of resources at mobile devices (Huerta-Canepa & Lee, 2008).

To open public resources for free access is not easy. As stated by (Shklovski & Chang, 2009), ‘as much as public space brings with a sense of egalitarianism… it can be fraught with adversary and conflict’. If the resource is public, then how users can access and control them? Who and why has priority? Should we consider users as equals? If the usage of a public resource interferes in other users’ tasks, should we grant it? What about the default usage of that resource (an information kiosk for example)?

Previous work based on the smart space concept (Nakajima & Satoh, 2004) (Shabi, Callaghan, & Gardner, 2005), develop an approach called Personal Operating Space (POS). Basically a POS system works by discovering available resources in the surroundings. These resources are then added into a personal space, a collection of public and private resources that can be used by the user’s applications. The main focus in the POS-based systems is the interaction of mobile devices with the available devices in the area. Extensions of the scheme have been proposed in (Xiang & Shi, 2005) and (Park et al., 2006) to include multiuser conflicts. In their work a conflict arises if two services require a resource already granted to another user. If that is the case, a resolution algorithm determines which service to run, based on a predefined priority. The main issue with this resolution mechanism is that it grants the execution to only one service, blocking the other processes until the conflicted resource is released. This affects the overall satisfaction or performance of the users as a community. Moreover, on our best knowledge, none of them tackles the conflict between the usage by a person in the area and the role of the device. Take as an example an advertisement display. The main role of that device is to display advertisements, and the city hall receives money because of that display. If we allow users to control the device and use it only for its personal purposes we are overriding its main purpose.

In order to overcome these limitations we propose a new scheme for resource management in public urban areas. Following the concept of POS, we create a knowledge base about the surrounding space by discovering nearby devices and users. These discovered resources are added as virtual resources into the mobile device, and can be used as regular resources by existing applications. When an application starts, it requests a set of resources. The system provides them based on availability. If a remote resource is considered in the provision, the system requests it. If available, the temporal ownership of the resource is granted to the requesting user. Temporal ownership means that a posteriori requests over the resource are handled by the user. Potential conflicts arise when another user requests the same resource. If the
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