

6 Software Infrastructure for Context-Aware Mobile Computing

C.L. Wang, X.L. Zhang, N. Belaramani, P.L. Siu, Y. Chow, and F.C.M. Lau

Department of Computer Science, The University of Hong Kong, Pokfulam Road, Hong Kong

6.1 Introduction

6.1.1 New Environment

Computing has been an ever-changing paradigm since the beginning of its creation. In the past decade, small, wireless devices, such as personal digital assistants, cell phones, and handheld PCs, etc. have become extremely popular. These light-weight devices, together with the ubiquitous wireless connections, have successfully supplemented desktop computing, allowing us to move about with computation capabilities and network resources at hand. Recent advances in embedded technologies are another thrust, aiming ambitiously to “computerize” everything. We shall see more and more smart widgets like watches, toys, or shoes, and intelligent appliances, such as microwave ovens and refrigerators, all empowered by embedded processors. We shall live and work in resource-rich environments, where devices of different functionalities and capabilities would readily offer their services to us, and these same devices, static or mobile, would be interconnected via wired or wireless connections, achieving a true ubiquity of computation and information services.

The scope of computation will be dramatically extended. It could happen anytime, anywhere, for any length of time, span any number and types of devices, and offer exciting services to support our everyday activities. We would be free to move around, having our computational tasks follow us and execute continuously, and taking advantages of the environments’ resources. This implies an extended form of mobile computing, i.e., context-aware mobile computing, in which the user’s mobility is decoupled from the device’s mobility, and the main goal of the supporting computational systems is to satisfy the requirements of the mobile user and provide appropriate services fitting their situations.

6.1.2 New Features

Context-aware mobile computing sets itself apart from conventional computing paradigms with the following new features:

- *Environmental heterogeneity.* Heterogeneity is a definite trait of future computing environments. The range of computing devices widens continuously, and they dramatically differ in computing capabilities, including storage, processing power, screen size, networking, to name a few. Such devices would seamlessly interact and coordinate among themselves to fulfill a user's requirement. Heterogeneity in this context is a double-edged sword: on the one hand, specialties of various devices allow for different user preferences; on the other hand, there is the challenge to bridge the differences of those devices. Meanwhile, as users move across spatial locations, they come upon different configurations of these physical spaces, including the devices equipped and the software installed.
- *Dynamism.* Dynamism comes from both the environment and the user. From the environment, variation in resource conditions, including memory consumption, battery life, network bandwidth, etc., induces changes that must be carefully attended to. User mobility introduces explicit changes of the execution location. On the other hand, human thoughts and behaviors tend easily to be in a state of flux. Some users might serendipitously change their goal or course of actions in reacting to a changed situation. To deal with changes is in fact a frequent and constant task for the computational systems.
- *Support for mobile people.* In traditional mobile computing genres, device mobility and code mobility have been extensively explored. The former considers mobile users moving with their devices across physical locations and geographical regions, without dropping the connection. The latter addresses dynamically relocating the execution and changing the bindings of code fragments to devices in which the execution would continue [8]. In context-aware mobile computing, however, the focus is on the people who are mobile. A user may or may not carry a device; rather, the environments along the way are responsible for receiving and executing the user's tasks. This differs from the code relocation in that (1) a task may span a set of local devices in each environment and (2) the task may not be resumed using the same code segments, due to changes in the environment. These issues were seldom addressed in previous mobile computing research.
- *Context awareness.* Context awareness refers to the ability of a computational system to understand the situation at hand and adjust its behavior accordingly. As emphasized by Dey [7], context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and the application themselves. It typically includes location; identity; activity and state of people, groups, and objects. Context awareness has become increasingly a reality because of the availability of inexpensive and powerful sensors for monitoring the environment. When computation moves beyond the desktop and into our environments, mechanisms must exist to reveal the relevant