Chapter 3.7
Embedded Agents for Mobile Services

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INTRODUCTION

A significant rise in the use of mobile computing technologies has been witnessed in recent years. Various interpretations of the mobile computing paradigm, for example, ubiquitous and pervasive computing (Weiser, 1991) and more recently, ambient intelligence (Aarts & Marzano, 2003)—have been the subject of much research. The vision of mobile computing is often held as one of "smart" devices operating seamlessly and dynamically, forming ad-hoc networks with other related devices, and presenting the user with a truly ubiq-uitous intelligent environment. This vision offers many similarities with the concept of distributed artificial intelligence where autonomous entities, known as agents, interact with one another form-ing ad-hoc alliances, and working both reactively and proactively to achieve individual and com-mon objectives.

This article will focus on the current state of the art in the deployment of multi-agent systems on mobile devices and smart phones. A number of platforms will be described, along with some practical issues concerning the deployment of agents in mobile applications.

BACKGROUND

In the most general terms, an agent is one entity that acts, or has the authority to act, on behalf of another. In terms of information technology, an agent is a computational entity that acts on behalf of a human user, software entity, or another agent. Agents have a number of attributes that distinguish them from other software (Bradshaw, 1997; Etzioni & Weld, 1995; Franklin & Graesser, 1996; Wooldridge & Jennings, 1995):

- **Autonomy:** The ability to operate without the direct intervention from any entity, and possess control over their own actions and internal state.
- **Reactivity:** The ability to perceive their environment and react to changes in an appropriate fashion.
- **Proactivity:** The ability to exhibit goal-directed behavior by taking the initiative.
- **Inferential Capability:** The ability to make decisions based on current knowledge of self, environment, and general goals.
- **Social Ability:** The ability to collaborate and communicate with other entities.
- **Temporal Persistence:** The ability to have attributes like identity and internal state to continue over time.
- **Personality:** The ability to demonstrate the attributes of a believable character.
- **Mobility:** The ability to migrate self, either proactively or reactively, from one host device to another.
- **Adaptivity:** The ability to change based on experience.

An agent requires some space where it can exist and function, and this is provided for by an agent platform (AP). An AP comprises "the machine(s), operating system, agent support software,…agent management components…and agents" (FIPA, 2000, p. 6). The AP allows for agent creation, execution, and communication.

The majority of computer systems currently in operation use algorithms that are based on the concept of perfect information. The problem is that in the real world, businesses often require software functionality that is much more complex than this (Georgeff, Pell, Pollack, Tambe, & Wooldridge, 1999). Typically, computational entities within these systems should have an innate ability to deal with partial information and uncertainty within their environment. These types of systems are highly complex and are intractable using traditional approaches to software development. The rate at which business systems must change, due to market pressures and new information coming to light, requires software architectures and languages that more efficiently manage the complexity that results from alterations being made to the code and the specifications.

Agent architectures, and in particular belief-desire-intention (BDI) (Rao & Geogeff, 1995) agent architectures, are specifically designed to deal with these types of issues and thus contain mechanisms for dealing with uncertainty and change. A problem with traditional systems is that they assume that they exist within a static or constant world that contains perfect information. The types of mobile systems that we are concerned with are dynamic and perhaps even chaotic, embedded with agents that have a partial view of the world and which are resource bounded.

Agents rarely exist in isolation, but usually form a coalition of agents in what is termed a multi-agent system (MAS). Though endowed with particular responsibilities, each individual agent collaborates with other agents to fulfill the objectives of the MAS. Fundamental to this collaboration is the existence of an Agent Communications Language (ACL), which is shared and understood by all agents. The necessity to support inter-agent communication has led to the development of an international ACL standard, which has been ratified by the Foundation for Intelligent Physical Agents (FIPA).

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