

Chapter XXII

On the Design of Multiagent, Context-Aware, and Mobile Systems

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ABSTRACT

This chapter addresses the software engineering dimensions associated with the development of mobile and context-aware multiagent systems. It argues that despite the growing deployment of such systems in different application domains little has been done with regards to their analysis and design methodologies. The author argues that the introduction of mobility and context awareness raises three main challenges that deserve a paradigm shift: the challenge of information integrity, service availability on mobile devices, and the complexity of decision modeling. Because they reflect different operational and procedural dimensions, the author argues that the conventional software engineering practices used with intelligent systems that possess other agency qualities need to be “re-engineered.” The chapter emphasizes that the envisioned methodology should reflect a thorough understanding of decision environments, domains representation, and organizational and decision-making structures. Furthermore, the chapter provides a description for the appropriate enablers necessary for integrated implementation.

INTRODUCTION

The significant advances exhibited in the field of mobile and wireless information systems have resulted in a rapid proliferation of mobile information devices and considerable improvement in their capabilities. Devices such as cellular or Web phones, laptop computers, and personal digital assistants (PDA) have developed from basic means of communication and simple electronic calendar management units into computing devices capable

of transmitting and processing data with wireless access to the Internet. Their uses in large scale distributed networks and grids allow new distributed applications to emerge in different domains. They have been widely used in e-business, e-learning, supply chain management, virtual enterprises (Jain, Aparicio, & Singh, 1999), information retrieval (Cabri, Leonardi, & Zambonelli, 2000), Internet-based auctions (Sandholm & Huai, 2000), distributed network management (Du, Li, & Chang, 2003), resource management and broadband intel-

ligent networks (Chatzipapadopoulos, Perdikeas, & Venieris, 2000), telecommunication services, and mobile and wireless computing (Keng, Ee-Peng, & Zixing, 2001). They have enhanced the functionality of such systems by improving the availability, accessibility, and management of decentralized repositories of concurrent data. In addition, the transformation of business environments and availability of mobile technology have encouraged the study of “context awareness” as a leading feature. Context awareness is directly and inexorably related to “mobility” where decision makers and users of mobile systems can use mobile networks to access data and carryout transactions using a wide range of intelligent units and applications.

MULTIAGENT MOBILE AND CONTEXT AWARE SYSTEMS

An intelligent agent is an autonomous, computational software entity that has access to one or more heterogeneous and geographically distributed information sources, and that proactively acquires, mediates, and maintains relevant information (Gasmelseid, in press). Intelligent agents are used to carry out functions on behalf of their users, other agents, or programs with some degree of autonomy using multiple information and communication platforms. While some agents have been used for information search and retrieval and the management of information overload, others perform repetitive activities and specific tasks such as scheduling and interface presentation, task delegation, users training, event monitoring, information search, matchmaking, and filtering (Wooldridge & Jennings, 1995; Gasmelseid, 2007).

Within the context of a distributed work environment, software agents can assist in facilitating coordination, cooperation, and interaction among different agencies (Gasmelseid, 2007). Their deployment in electronic commerce, traffic control, healthcare provisioning, portfolio management, and telecommunications proved their relevance to

handle complex, distributed problems involving a multiplicity of interconnected processes whose solutions demand the allocation of fusion of information and expertise from demographically distributed sources (Gasmelseid, 2006). Using an agent in the healthcare sector, for example, patients can receive remote monitoring and telemedicine services from one or more healthcare service providers (i.e., hospitals, physicians, nurses, pharmacies, laboratories, clinics, emergency centers, and consultants) in a high quality cost effective form. In a distributed healthcare setting, general practitioners, hospital specialists, nurses, and home care organizations have to work together to provide the appropriate care to a sick patient (Huang et al, 1995). Industrial applications of agent technology, on the other hand, include the application of contract net task allocation protocol in a manufacturing environment. In process control, multiagent systems have been applied in electricity transportation management, and particle accelerator control (Jennings & Wooldridge, 1998).

In response to the growing situational and business complexities and the increasing focus on resource sharing, agents are usually assembled into “multiagent organizations” and structures rather than being used as individual components. Due to the lack of an universally accepted definition for the concepts that govern and dictate “agency,” multiagent systems are described in accordance with their functions based on the qualities possessed by the agents making them up.

The transformations exhibited in business environments, the growing importance of “delegation” and resource sharing as a business imperative, and the improvement of technological platforms have moved “mobility” and “context awareness” to the list of highly acknowledged agent qualities. While such qualities are not usually considered on individual bases, they are coupled with other qualities in pursuit of orchestrating and harmonizing the functionality of the entire multiagent organization. Therefore, when mobile agents are used to constitute the entire multiagent system they can jointly

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