Abstract

Nowadays the advances in miniaturization of electronic systems have driven development artifacts or devices incorporating computing and communication capabilities. These devices can provide to users (such as the people at home, workers in the office, users in a transport system, etc.) a range of services in different environments, thanks to its embedded technology. This potential for processing and communication, is allowing to create new distributed applications, where the personal computer does not have the main role, but the different devices embedded in the environment: sensors, interfaces, actuators, mobile phones, etc. This has generated novel application areas such as Internet of Things, Mobile Computing, Sensor Networks, Ubiquitous Systems, Ambient Intelligence, etc.

These advances have led to the development of a new paradigm *interaction oriented computing*, namely, computation occurs through acts of communication between entities. Therefore, it is easy to think that this paradigm requires from a design point of view, the development of applications on different software and hardware platforms, due to the heterogeneity of computer systems, languages, operating systems, and objects (physical devices: sensors, actuators, interfaces, etc.) dispersed in the environment.

However, Software Engineering-based Multi-Agent Systems, in particular Open Multi-Agent Systems (Virtual Organizations) have the ability to address these challenges. Moreover, several software development methodologies have adopted a *model-driven* approach for analysis and design. A similar approach can be adopted in multi-agent systems to improve the development process and the quality of agents-based software. The model-driven development provides an appropriate support for developing such systems since it allows us to use abstract models as main elements in the design of the system through interconnection of a set of visual components.

In this work we propose the development of ubiquitous systems using a virtual organization, creating a *Ubiquitous Virtual Organization*, which is designed using the approach of model-driven development. In more detail, this work presents three proposals. The first presents a set of meta-models to design a *Ubiquitous Virtual Organization*, called πVOM, using concepts abstracted from general met-

hodologies and platforms agents, which allows you to design applications using high-level abstractions general, avoiding implementation details of low level. Subsequently, two transformation models are presented. These transformations can generate the implantation model of the system (agents, institutions and devices), through semi-automatic transformations given by *model-driven* methodology, reducing the gap between design and implementation phases for this type of system.

The second proposal presents an architecture for implementation that structure defining a service-based functional layers, which supports the interaction entities of the virtual organization. The architecture allows interoperability implementation different entities, software and hardware platforms, providing members virtual organization the ability to manage and control devices environment (the ubiquitous system).

The third proposal presents an execution platform for embedded agents called Andromeda, allowing agents to execute embedded operating system *Android* that meet the agent model πVOM. Agents in Andromeda can accessing the devices in the environment, as occurs in the ubiquitous systems.

The proposals were evaluated empirically with two examples, that display their kindness.