Chapter 1

Solving Conflicts in Agent-Based Ubiquitous Computing Systems:
A Proposal Based on Argumentation

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Abstract

Agent-based ubiquitous computing environments have many sources of complexity. One of the most important is derived from the high number of agents which must survive in such kind of system. In systems with a high population of agents, conflicts are very frequent. Thus, there is a need for highly efficient techniques to solve conflictive situations, when they are produced. In this chapter, we propose an approach based on argumentation to solve authorization conflicts. Authorization decisions are taken with authorization policies and conflicts are solved by the agent themselves by arguing.

Keywords: Pervasive environments, argumentation, conflicts, authorization policies

1.1 Introduction

In pervasive environments, one of the main concerns must be to enable effective coordination mechanisms for devices, services, applications and users [Perich et al. (2004)]. Due to the high number of potential communicating entities in the system, situations in which a drop of productivity may occur are highly probable. More specifically, these situations are produced because of different conflicts among entities. In consequence, this kind of systems must be prepared for dealing with conflicts. Conflicts may arise in coordination tasks within Multi-Agent Systems (MAS), because of conflicting goals or beliefs. When there is a conflict of this type, the mechanism for settling on it goes through a negotiation process. Think, for example, on a ubiquitous system which is in charge of managing a building with many offices and humans. The latter are considered as users of the system by means of hand held devices, smart phones or any laptop or PC, which are connected to the applications and services of the building by using the network. When the system is based on autonomous agents, they probably have a partial and imprecise vision of the world they live in. If, for example, an emergency situation is produced due to a fire in the building, the autonomous agents could be responsible of deciding how to manage security of the building (e.g. avoid access to persons into unauthorized places).
and, at the same time, allowing a quick and effective evacuation. It might be the case that a user needs to get out of the building through a corridor which has a forbidden access status with respect to that user. How to proceed in this case to preserve the integrity of the workers in the building?

Traditional mechanisms dealing with such problems are focused on avoiding conflict occurrence, as for example social laws [Shohama and Tennenholtz (1995)], coordination through cooperation when agents are benevolent [Lesser (1999)] and truth maintenance systems [Doyle (1979)], among the most relevant. Social laws are difficult to implement in rather simple environments and they seem to be non-applicable in complex environments like those of pervasive systems. Cooperation implies the assumption of benevolent agents. However, since MAS in pervasive scenarios are open systems, some agents could have private interests, and even being willing to cooperate, they will pursue their own goals. Hence, it seems hard to define a dynamic cooperation plan needed here. Truth maintenance systems try to explain why conflicts happen by registering the reasons that derive the conflicting conclusions, but they are not able to reason about the conflict itself, i.e., the sources of the conflict are not taken into consideration. On the other hand, negotiation processes [Rosenschein and Zlotkin (1994)] have shown to be useful in pervasive systems to enable effective coordination once conflicts have appeared. This kind of negotiation is based on self-interested agents, as a pervasive system, in its general sense, is an open system where agents may not be willing to cooperate for anything. In this approach, conflicts are taken as unavoidable; therefore some methods are needed to solve them. Argumentation-based negotiation processes [Parsons et al. (1998)] are a set of specific techniques that relies on argumentative theories in order to solve conflicts, by extending the negotiation proposals with the reasons or foundations associated to each proposal.

Argumentation deals with several fields in knowledge engineering [Carbogim et al. (2000)]. One of the outcomes in this extensive line of work is an abstract and generic framework for reasoning under incomplete and inconsistent information [Prakken and Sartor (1996)]. In this paper, such a generic framework has been instantiated using the Semantic Web [Berners-Lee et al. (2001)] information representation approach, i.e. OWL ontologies. As a result, all the knowledge managed in the pervasive system, including arguments and rules themselves, is represented by means of Semantic Web ontologies. Hence, we are focusing on an innovative research line that is focused on automatically creating and attacking arguments during the argumentation process.

The main goal of this chapter consists of taking the first steps in combining an argumentation system to solve beliefs conflicts in pervasive environments. As a result, the argumentative approach is introduced in ubiquitous computing systems as a manner to solve the different types of conflicts that are found among autonomous entities. The normal security procedures of most working environments such as the one mentioned above are managed by a policy-based framework. In this kind of systems, policies are used by the pervasive infrastructure to authorize software entities to perform critical actions, which directly influence the security of workers when there is an emergency situation. These policies have the form of if-then rules and are manually defined by the system administrator.

The rest of the chapter is structured as follows. Section 1.2 introduces the kind of conflicts that could be found in the context of distributed systems management through rule-based policies, more specifically through authorization policies. Section 1.3 is devoted to give some notions of argumentation theory, at a basic level. In section 1.4, the use of the argumentative approach in ubiquitous computing systems is illustrated with a concrete example. Section 8.6 describes some of the most relevant works related with the ideas presented in this chapter. Finally, section 5.3.6 includes most important conclusions extracted from the light of this chapter and the future work.

1.2 Classification of authorization policies conflicts

Conflicts [Lupu and Sloman (1999); Syukur et al. (2005)] raised by evaluating policy rules may be categorized into two different types, depending on whether the application domain is taken into