

Trust Management Model based on Fuzzy Approach for Ubiquitous Computing

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ABSTRACT

The current state of ubiquitous computing has been greatly influenced by emerging networking developments like Internet of Things (IoT), Future Internet etc. Adequate trust management is crucial to provide security. The entities involved in communication must be trusted for specific purposes depending on their role. Using trust model, devices can run trust computations and guide their behaviors. To this effect, a method is needed to evaluate the level of trust between devices. Trust models investigated so far discuss that devices face problems when communicating as transforming trust relationships from real to virtual world requires the negotiation of trust based on the security properties of devices. However, these models are developed in limited devices. This paper proposes a distributed trust model for device-to-device communication in ubiquitous computing. Mathematical model based on fuzzy rules to establish trust is presented. Fuzzy simulation of the model is presented to validate the findings. Simulation results show that proposed model calculates fuzzy trust values reliably.

KEYWORDS

Distributed Trust Model, Fuzzy Rules, Trust, Trust Computation, Trust Management, Trust Model, Trust Score, Ubiquitous Computing

INTRODUCTION

In near future, the internet is going to make the world where physical things would consistently be incorporated into data systems which would provide smart services to users. These interconnected things, for example, sensors or portable gadgets would generate and gather volumes of information which can be further processed to discover helpful data to strengthen intelligent and ubiquitous services (Yan, 2014). Ubiquitous applications and services have been established and are spreading into the market which covers a variety of domains.

Trust management plays an important role in ubiquitous communication. It helps in decision making and to identify risks. Trust relationships occur naturally in many diverse contexts in open computing environments such as collaborative systems, e-commerce, interpersonal interactions, social networks, and semantic sensor web. The reputation of an entity is a derived measure from direct or indirect knowledge of earlier interactions of entities which are used to evaluate the level of trust put into an entity. Distributed trust decision making takes into account trust in the entities such as the information source, the processors of information, the elements of the communications network across which the information is transmitted, etc. (Cho, 2011). The trust is an inherent issue in ubiquitous computing environments as it impacts large-scale distributed systems (Ranganathan, 2004). Trust is

complex notion with respect to the qualitative performance requirements of communication systems. There is no any universal concept of trust that is applicable to all domains. As per Webster's dictionary, trust is assured reliance on the character, ability, strength or truth of someone or something or one in which confidence is placed (Webster's Dictionary). It could be reasonable to say that trust is a measure of the degree of confidence one has on something and thus trust values are better described by the degree stating the confidence someone has on someone else doing an action, or it is a measure someone has in someone else. The computation of this measure is trust computation. In the context of this paper, trust is considered as a multi-valued notion and hence multi-valued logic i.e. fuzzy logic is used to deal with various degrees of trust. With modern forms of communication, the trust may be derived from on demand conditions and in a distributed way. Considering device level requirement, Trust management in ubiquitous computing for the security of devices is left unaddressed. This paper presents a generic trust model which computes trust score using fuzzy rule base and addresses above requirements in ubiquitous computing. This model is simulated using fuzzy inference system and validated with a mathematical model.

RELATED WORKS

Overview

Researchers have long realized the need to deal with trust and reputation in pervasive computing and have proposed many approaches. The notion of trust management has formed a subject of study since work in (Blaze, 1996), (Blaze, 1998) shows a language for specifying trusted actions and trust relationships; they also describe a prototype implementation of a trust management system, called PolicyMaker. It puts specific emphasis on access control decisions rather than general trust management (e.g., it does not address trust evolution issues). Many researchers have focused on both direct as well as indirect trust while in particular cases either of these is investigated based on the target environment. Trust aids in various ways to provide and enhance security in ubiquitous computing. Here, a trust management solution needs to handle some specific features of trust like trust model designing, techniques for trust evaluation and enhancement in security using trust systems. The trust model in (Denko, 2008) considers trust value as a probability that a device provides satisfactory interactions with its neighbors and a distributed trust management using recommendation was constructed. Probabilistic trust management scheme for pervasive computing of (Denko, 2008) is extended in (Denko, 2011). In (Denko, 2011), trust management scheme based on Bayesian approach is presented, which allow a device to find other suitable devices with which to interact while detecting those that are malicious. It also allows a device to judge the trustworthiness of another device with which it interacts and to make a better use of recommendations. SecuredTrust model in (Das, 2012) considers the malicious behavior of communicating agents in multiagent systems. It also focuses on providing quick response to a malicious agent's oscillating behavior. In multi-agent systems, it is important to have an even distribution of workload among service providing agents for good service quality. This model proposes a load balancing algorithm based on various factors related to trust evaluation of an agent. A trust model based on the recommendation trust is proposed in (Wang, 2013) for P2P networks with an application on file sharing system. This model uses service trust value to indicate node's recommendation trust and can prevent a node with higher service trust value to reject a normal node by distinguishing between the service trust value and recommendation trust value. The context-aware trust model is presented in (Ma, Y., 2013) to deal with the data sparsity problem caused by the diversity of services and contexts using Leader-Follower clustering based direct trust evaluation algorithm. However, the main focus is on the direct trust evaluation and the indirect trust from recommendations is not investigated. A Self-Organizing Trust Model (SORT) for Peer-to-Peer Systems in (Can, A. B., 2013) presents distributed algorithms that allow a peer to find trustworthiness of other peers based on past interactions and recommendations. By using two

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