Chapter II

A Unified Taxonomy Framework of Trust

Weiliang Zhao, University of Western Sydney, Australia

Vijay Varadharajan, Macquarie University, Australia

George Bryan, University of Western Sydney, Australia

Abstract

In this chapter, we provide a formal definition of trust relationship with a strict mathematical structure that can reflect many of the commonly used notions of trust. Based on this formal definition, we propose a unified taxonomy framework of trust. Under the taxonomy framework, we discuss classification of trust. In particular, we address the base level authentication trust at the lower layer and a hierarchy of trust relationships at a higher level. We provide a set of definitions, propositions, and operations based on the relations of trust relationships. Then we define and discuss properties of trust direction and trust symmetry. We define the trust scope label in order to describe the scope and diversity of trust relationship. All the definitions about the properties of trust become elements of the unified taxonomy framework of trust. Some example scenarios are provided to illustrate the concepts in the taxonomy framework. The taxonomy framework of trust will provide accurate terms and useful tools for enabling the analysis, design, and implementation of trust. The taxonomy framework of trust is first part of research for the overall methodology of trust relationships and trust management in distributed systems.
Introduction

Trust has been studied in multiple dimensions in the computing world. Trust management and trustworthy computing are becoming increasingly significant. Trust has been studied in trusted systems (U.S.A. National Computer Security Council, 1985) and trusted computing (Felten, 2003; Landauer, Redmond, & Benzel, 1989). Marsh has tried to formalize trust as a computational concept (Marsh, 1994). Multiple community-based reputation systems (Jøsang, 1999; Jøsang & Knapskog, 1998; Manchala, 2000; Mui, Mohtashemi, & Halberstadt, 2002; Wang & Vassileva, 2003; Xiong & Liu, 2003), trust negotiation systems (Huhns & Buell, 2002; Winsborough, Seamons, & Jones, 2000; Winslett et al., 2002) and trust management systems (Blaze, Feigenbaum, & Keromytis, 1999; Blaze, Feigenbaum, & Lacy, 1996; Chu, Feigenbaum, Lamacchia, Resnick, & Strauss, 1997) have been proposed. However, a clear and comprehensive definition that can be used to capture a range of commonly understood notions of trust is still lacking.

XML-based Web services technologies have been rapidly evolving since 1999. Web services technologies address the challenges of distributed computing and B2B integration. There is a huge number of service-oriented applications on the Internet and they are coupled loosely. Web services technologies target at loosely coupled, language-neutral and platform-independent way of linking applications for business process automation within organizations, across enterprises, and across the Internet. There is no centralized control, and the users are not all predetermined. Normally, the computing components involved in an e-service can belong to different security domains and there is no common trusted authority for the involved entities. The new technologies of Web services make the related issues about trust more important than ever before. The properties of trust and how to define/model trust relationships are important concerns in the analysis and design of Web services. The issues of trust are also broadly embedded in broad spectrums of Web services such as WS-trust (Della-Libera et al., 2002; Anderson et al., 2004), WS-security, WS-policy and WS-federation. Unfortunately, in all these documents, the details of classification and properties of trust have not been discussed.

Our main objective is to develop a unified taxonomy framework of trust that can provide accurate terms and can be used as enable tools to analyze and model trust relationships in distributed environments. This chapter is mainly based on the results of our previous research (Zhao, Varadharajan, & Bryan, 2004; Zhao, Varadharajan, & Bryan, 2005). We outlined a formal definition of trust relationship and provided a set of operations and definitions about the relations of trust relationships (Zhao et al., 2004). We discussed the classification of trust and provided a set of definitions for the properties of trust that include trust direction, trust symmetry, scope, and diversity of trust relationships (Zhao et al., 2005). The unified taxonomy framework of trust is composed of a series of definitions in Zhao et al. (2004) and Zhao et al. (2005) and it is illustrated in Figure 1.

Our current unified taxonomy framework of trust includes the formal definition of trust relationship, types of trust, relations of trust relationships, and properties of trust relationships. The formal definition of trust relationship will be described in section “Definition of Trust Relationships”; the types of trust will be described in section “Classification of Trust.” The relations of trust relationships will be described in section “Relations of Trust Relationships.” For the properties of trust relationships, the current unified taxonomy