

# Chapter 28

## Knowledge Transactions in Mobile Environments

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### ABSTRACT

*Knowledge transaction processing is a very new research area in mobile environments. The main goal of this chapter is to explore and study knowledge representation, reasoning, and transactions in mobile environments. As the outcome of the discussion, this chapter presents and formalizes a knowledge transaction language and model for use in mobile computing environments. In addition, this research further formalizes a framework for a mobile logic programming multi-agent system. The formalization of the knowledge transaction model and the multi-agent system framework herein presented is a first step towards a rigorous and consistent study of knowledge base and intelligent agent in mobile environments.*

### INTRODUCTION

Knowledge representing and reasoning are two important aspects of artificial intelligence. Within the intelligent agent community, numerous frameworks/models have been developed for problem solving, knowledge representation and reasoning, such as the stable model/answer set (Baral, 2003; Bordini 2006; Toni 2005), SMODEL, DLV and XSB model (Eiter, 1997; Gebser, 2008; Nemela, 1996; Rao, 1997). These models are knowledge oriented with declarative semantics, and their specification language can specify the details of

knowledge transactions. However, the discussion of these models is limited to conventional stationary environments, and has not been extended to mobile environments.

Within the mobile system community, on the other hand, many efforts have been invested in developing mobile agent systems. These efforts have effectively led the development of mobile agent systems such as Telescript (White, 1996), IBM's Aglets (White, 1996), Concordia (Walsh, 1998), Voyager (Glass, 1998), Agent TCL (Glass, 1998), KLAVA (Bettini, 2002; Deugo 2001), and recent works on MEMPHIS (Papadakis, 2006),

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JIMAF (Fortino, 2008), ABRTTDMMS (Chen, 2009). However, these well-known mobile agent systems are not knowledge oriented.

In mobile environments, current research for transaction processing concentrates on data (Ahamad, 1995; Bettini, 2002; Bhalla, 2003; Dang, 2003; Deugo 2001; Eidsvik, 2006; Imielinski, 1996; Madria, 2008; Ram, 2004) rather than knowledge transactions. As open questions of mobile computing, so far no knowledge transaction has been formally studied, no model has been formalized to process knowledge transactions and no framework has been formalized for multi-agent systems in mobile environments. It is both necessary and meaningful to formalize a knowledge transaction model and a multi-agent system framework in mobile environments, because this will provide a foundation to further the study of knowledge transactions and intelligent agents in mobile systems.

Section 1 of this chapter formalizes a rule based knowledge transaction model for mobile environments. The formalized model can be used for knowledge transaction representation, formalization and knowledge reasoning in mobile environments. Section 2 of this chapter models and formalizes a mobile logic programming multi-agent system (MLPMAS). Based on this model, knowledge based transactions can be studied in such a mobile multi-agent system. In addition, knowledge transaction is formally defined and modelled in these mobile multi-agent systems.

## **1. A KNOWLEDGE TRANSACTION MODEL FOR MOBILE ENVIRONMENTS**

In this section, we present and formalize a rule-based knowledge transaction model for mobile environments. The resulting knowledge transaction language and model can be used for knowledge transaction representation, formalization and knowledge reasoning in mobile environments.

Logic programming is used as a mathematical tool and specification method. The formalization starts with proposing a mobile environment architecture for knowledge study and defining the knowledge transaction representation language, and then imposes a set of rules to capture the features of knowledge transaction in mobile environments. Lastly, a knowledge transaction model is formally defined. A case study provides evidence that the knowledge transaction model is applicable for practical problem domains in mobile environments.

### **1.1 Transaction Processing in Conventional and Mobile Environments**

Transaction and transaction processing have been widely studied in conventional environment. Ullmam explained the transactions as follows (Ullmam, 1982): “A transaction is a collection of one or more operations on the database that must be executed atomically; that is, either all operations are performed or none are.” Claybrook defined a transaction as follows (Claybrook, 1992): “Informally, a transaction is the execution of a program (or program segment) that performs some function on one or more resources such as shared, online databases or files. A transaction may be considered as an abstraction that is managed by a transaction processing (TP) system. A transaction is an atomic unit of execution that can be modeled as

$$T = a_1 a_2 \dots a_n$$

where the  $a_i$  are actions (operations) such as read, write, delete, rewrite, open, close, start\_trans, commit\_trans, abort\_trans, and so on.”

Gray described the transaction and transaction processing as follows (Gray, 1993): A Transaction Processing system includes application generators, operations tools, one or more database

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