UNIVERSITI PUTRA MALAYSIA

TRANSACTION MANAGEMENT MODEL FOR MOBILE DATABASES

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By

ZIYAD TARIQ ABDUL-MEHDI AL-KHINALIE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,

in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

November 2006

DEDICATION

To the memory of my Grandmother,

To my parents: Dr. Tariq Al-Khinaie and Dr. Nabiha Al- Sammerai

To my Wife: Amna and my Daughter: Nudie

To my sister: Nada

Ziyad

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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November 2006

Chairman: Associate Professor Dr. Ali Mamat, PhD

Faculty: Computer Science and Information Technology

Transaction support is crucial in mobile data management. Specific characteristics of mobile environments (e.g. variable bandwidth, disconnections, and limited resources on mobile hosts) make traditional transaction management techniques no longer appropriate. This is due the fact that the Atomicity, Consistency, Isolation and Durability (ACID) properties of transactions are not simply followed, in particular the consistency property. Thus, transaction management models adopting weaker form of consistency are needed and these models can now tolerate a limited amount of consistency. As a result, several transaction management models for mobile databases have been proposed, each of which has attempted to overcome some issues pertaining to transaction processing in mobile environment. However, issues such as

(a) only one mobile host (MH) is allowed to update the data item

(b) large number of rejected transactions

(c) commit time execution of transactions at mobile host (MH) is large

are not well handled.

The proposed the model with the aims at solving the stated issues. The main idea underlying the model is that transaction execution can be done at the base station (BS) and mobile host (MHs). Transactions at a MH can update data locally and then pre-commit. When the MH connects to the BS, these pre-committed transactions are sent to the BS and re-executed as base transactions (BT) to maintain data consistency at the BS. BTs are serialized on the master data stored at the BS. This will results in data consistency.

The availability of data item at MHs makes the execution of transaction at MHs possible. Each MH is allocated some value δ_i of data item, and the rest of it is kept at the base server. By having the own this resource, a transaction at a MH is allowed to update the data item within the limit of δ_i. The model has been implemented and the result has shown that the model works correctly as expected.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGURUSAN TRANSAKSI UNTUK PANGALAN DATA BERGERAK

Oleh

ZIYAD TARIQ ABDUL-MEHDI ALKHINALIE

November 2006

Pengerusi: Profesor Madya. Ali Mamat, PhD

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Sokongan transaksi adalah penting dalam pengurusan data bergerak (mobile). Ciri-ciri khusus bagi persekitaran bergerak (contohnya lebarjalur berubah, pemutusan, dan kekurangan sumber pada hos bergerak) menjadikan teknik pengurusan transaksi tradisional tidak lagi sesuai. Ini adalah disebabkan sifat-sifat Atomicity, Consistency, Isolation and Durability ACID bagi transaksi tidak mudah diikuti, khususnya sifat konsisten. Oleh yang demikian, model pengurusan transaksi yang mengambil bentuk lemah konsisten diperlukan dan model-model ini boleh bertoleransi dengan konsisten dalam nilai yang terhad. Justeru itu, beberapa model-model pengurusan transaksi untuk pangkalan data bergerak telah dicadangkan, setiap satunya mempunyai percubaan untuk mengatasi beberapa isu berkenaan pemprosesan transaksi dalam persekitaran bergerak. Bagaimana pun, isu-isu seperti

a. hanya satu hos bergerak (MH) dibenarkan untuk mengemaskini objek data

b. bilangan transaksi yang ditolak adalah besar

c. masa akur (commit) bagi transaksi di hos bergerak adalah besar

tidak ditangani dengan begitu baik.

Kami telah mencadangkan model dengan tujuan mengatasi isu-isu yang dinyatakan. Idea utama yang mendasari model ini adalah pelaksanaan transaksi boleh dilakukan pada stesyen asas (BS) dan hos mobil (MH). Transaksi pada MH boleh mengemaskini data setempat dan kemudian pre-commit. Bila MH dihubungkan dengan BS, transaksi pre-commit dihantar ke BS dan dilaksanakan sekali lagi sebagai transaksi asas (BT). BT disirikan (untuk dilaksanakan) ke atas data induk yang disimpan di BS. Ini akan menyebabkan data konsisten. Kewujudan data item di MHs membuatkan perlaksanaan transaksi di MH terjadi. Setiap MH diperuntukkan suatu nilai δ_i bagi item data, dan nilai selebihnya akan disimpan di stesyen asas. Dengan adanya sumber ini, transaksi pada MH dibenarkan untuk mengemas kini item data dalam had δ_i. Model ini telah dilaksanakan dan keputusan telah menunjukkan bahawa model ini berfungsi dengan betul seperti yang dijangkakan.

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I certify that an Examination Committee has met on 28th November 2006 to conduct the final examination of Ziyad Tariq Abdul-Mehdi Al-Khinalie on his Doctor of Philosophy thesis entitled "Transaction Management Model for Mobile Databases" in according with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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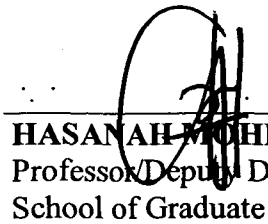

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

ZIYAD TARIQ ABDUL-MEHDI AL-KHINALIE
Date: 22-3-2007

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1SR	One-copy Serializability
BT	Base transactions
BS	Base station
DBMS	Database Management System
FS	Fixed host
MH	Mobile host
MT	Mobile transaction
ACID	Atomicity, Consistency, Isolation and Durability

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, several research articles regarding distributed databases were published. Among them were those by (Padmanabhan *et al,* 2006; Bottcher *et al*, 2006; Deris *et al,* 2004; Agrawal & El-Abbadi, 1996, 1990; Holliday *et al*, 2002; Berstein *et al*, 1987). The articles revealed that data replication management is one of the current issues in distributed database that has yet to be solved. It was on this basis that this study was initiated.

A mobile database system is one of the major recent developments in the database area, where it moves from centralization, which resulted in monolithic database towards more decentralization and autonomy of processing (Elmasri and Navathe, 2000). Many of commercial database systems such as Oracle8 and IBM DB2 propagator provide the required support for data distribution and inter-database communication (Ozsu and Valduriez, 1999). As new communication technologies are emerging, wireless and mobile computing concepts become reality and allow for even higher degrees of "distributed ness" and flexibility in mobile databases.

CHAPTER 1

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1.1 Background

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A mobile database system is a special multidatabase system on a mobile computing environment. It allows mobile hosts to access and manage data stored on several autonomous and heterogeneous local database systems located on different parts of the wired or wireless network. Transactions in a mobile database system may access data from several local databases at different nodes. Management of these transactions requires different approaches in mobile databases than in multidatabase. This is mainly due to the fact that a mobile host is not suitable to manage a global transaction by itself due to the nature of the mobile computing environment to be described. Usually this management is done by the mobile host's base station or by coordination of them.

Due to the nature of the mobile computing environments, transaction management has to be reevaluated for mobile databases. The transactions in mobile computing environments are usually long-living transactions, possibly covering one or more disconnected durations. Supporting disconnected operation (i.e. allowing a mobile host to update autonomously during disconnection) raises issues in consistency. Providing disconnected operation also requires some pre-caching of data that will be required for the necessary operations to be performed during disconnection.

In general, transactions in mobile databases require relaxed Atomicity, Consistency, Isolation and Durability (ACID) properties. There are several works on mobile transactions, each addressing some of the issues in mobile transaction management. We will explain some of them in chapter three.

With advances in mobile processing and distributed computing that occurred in the operating system arena, the database research community did considerable work to address the issues of data distribution, distributed transactions management, distributed query processing, and etc. (Connolly and Begg, 1999). One of the major issues in data distribution is replicated data management at mobile host (MH). Replication can improve data availability but a proper approach is needed to maintain data consistency.

1.2 Data Replication

Although data replication is not necessarily in mobile transaction management issue, it is at the heart of several works on mobile transactions models (Turker and Zini, 2003). The reason is that common approaches to increase MH autonomy are based on data replication or data caching.

Replication is the act or result of reproducing- in short, a copy. As such, any type of data processing object can be replicated. Note that the definition describes replication as the act of reproducing. Therefore replication is much more than simply the copying of any object; it must also address the management of the complete copying process (Buretta, 1997). Thus, data replication is much more than simply copying data between data stores. It encompasses the administration and monitoring of a service that guarantees data consistency across multiple disconnection hosts in a mobile environment.

In this evolving world of distributed databases, data replication plays an increasingly important role. It is a useful technique for distributed database system where an object