Transactions Management in Mobile Database

Vehbi Ramaj[1], Ylber Januzaj[2] and Ymer Januzaj[2]

**[1] University of Peja "Haxhi Zeka"
Peja, Kosovo**

**[2] Contemporary Sciences and Technologies, South East European University
Tetovo, Macedonia (FYROM)**

Abstract

The importance of database in many fields such as modern business, government institutions, schools etc. is rapidly growing up. Nowadays many business processes and many other applications depend on database. The data onto these databases may be required to be accessed by smart devices such as mobile phones. In this paper we show how these data will be adjusted for mobile computing. Then we describe transaction management in mobile database systems, we describe how mobile transaction can be defined and we show how these transactions will be executed. We focus on presenting an architecture of mobile database systems which is based on PC (Personal Communication System) and GSM (Global System of Mobile communication), while both of them serves to build the basic foundation for transaction management. We describe some concurrency control mechanisms which are very essential for managing transactions and we show some transaction issues in mobile database.

Keywords: *Mobile database, transactions, operations, recovery.*

1. Introduction

Activities on mobile database started in beginning of 90's. There are many researches in mobile database area however there is still a lot to be discovered. Nowadays almost all of us use mobile devices as mini-computers and we travel with these devices which enables us to be connected to specific information almost all the time. The number of these devices is growing rapidly day after day and they are almost a part of us and a part of business world. In many researches we can notice that mobile database systems are referred to a common DBMS architecture (client-server and conversely), while client is always a movement device which consumes data and server is static device which serves data and they must have a permanent connection in order to exchange information to each other. In addition client is connected to the server through mobile equipment such as: wireless or GSM, while it takes necessary information from database. In this paper we focus on information recovery issues while we present some useful information for recovery schemas, we show protocols which enables us to recover our data, we see how information first will be collected then those information will be refined in order to provide a successfully recover of our database. We describe these protocols carefully because mobile database is more complicated versus other databases, but first we try to clarify to the users the idea of the mobile communication to achieve a clear idea for mobile database. First we start with mobile function to clarify to the users how they operate.

2. Mobility Environment

Nowadays information retrieval from users with mobility devices such as PDA (Person Digital Assistant), Smart phones, etc. has become a common activity. Also navigational systems in vehicles are now a standard system assistance using a specific database. These devices are very useful and usable, because they can retrieve desired information from the database from any location through wireless channels. As it is mentioned in [1] they have one serious limitation, such as: information flow in these systems is only from the server to the user. This limitation does not allow users to manipulate with the database because there is no access to the server, as a result users need to manipulate with these servers in order to access specific data. Database developers and trade organizations have a common vision of building an information management system in a mobile platform which is capable of providing complete transaction management functionality and access to database from every place and at any time ([1], [3], [4]). Traditionally the databases are processed by the processing units stationary: the server or client. They use spatial coordinates in order to processing units, these coordinates are fixed and users go through those given coordinates for the processing of their claims. According to this model of information management, both processing units and their users are stationary at the time of processing the data. An important issue of mobile database is that users should be free to move everywhere in order to access its data and process them, while until the late this was a barrier on mobile database. Next we will show a sketch which describes the concept of an information space fully connected with people's expectations. Each object of the real world with some functionality is associated with other objects wireless connection ([5], [7], [2]). For example, a bank or a person is associated with the conference, bus, submarines, while all these connection are done with wireless connectivity of mobiles. In addition a person or a bank can provide full information for all other objects. Consider the parents who are working every day, and their children are in school, and each parent works in another location. Each member of family would like to provide an immediately access to see their child state in order to be secured. If so a CEO of a company would like to be informed for all activities of his company in order to provider an efficient management.

Figure 1. Mobility environment

In Figure 1 we can see the mobility environment which helps us to control things in different parts of the world. This paradigm has a limitation such as doesn't allow "every time and everywhere" access on information which are stored in a specific database while it is an outstanding requirement from the users and industries. Users wish that a mobile device (mobile, PDA, smart-phone, etc.) must have the ability to manage transactions, while transactions enable the users to perform different activities such as: money transfer, reservation, stock market etc. while it is in movement.

2.1. Types of mobility

A mobile framework is composed by two components such as: wired and wireless users ([6], [11]). Wireless implements terminal mobility and personal mobility in order to eliminate some of the spatial and temporal limitations of the data processing activities, while wired users are limited because of the nature of infrastructure. Next we give description about mobility and we talk about types of mobility and give description for terminal mobility and personal mobility.

2.1.2. Terminal mobility

This allows a mobile unit (laptop, cell phone, PDA, etc.) to access services from any location desired, moving or stationary, regardless of who is the carrier unit ([6], [14]). For example, a cell phone can be used by its owner and it can also lend to another for use. Terminal mobility, it is the responsibility of the wireless network to identify communication device. Figure 2 illustrates the idea of moving the terminal. A person instead of C (Longitude and Latitude = C) uses mobile units to communicate with the driver of the car in the country A. He still can establish communication with the driver of a new place D despite the movement of the car from A to B. It can be used by different countries and from different machines such as mobile, residential telephones, etc.

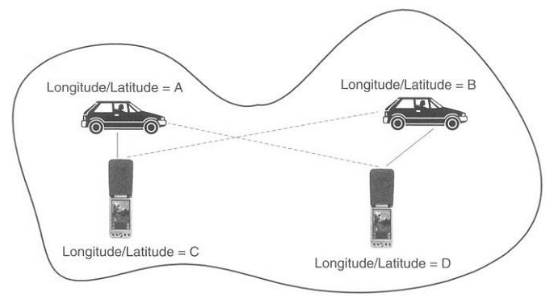

Figure 2. Terminal mobility

In the movement terminal, from a telecommunications perspective, network connection point (referred to as an access / network termination points) was identified as a party. Thus, the connection is established between two points and not between two men called each other. This type of connection in a session allows the use of communication devices that will be shared between anyone.

2.1.2. Personal mobility

Personal mobility is the ability that is given to a human to communicate with each other every time and everywhere ([8], [9], [10]). Thus, a user does not have to perform any device communication but he can use every communication tool for efficient communication with the other party. This structure requires an identification scheme to verify the person who wants to communicate. Figure 3 illustrates the idea of personal mobility. A person instead C communicates with the machine in its place a used PDA and location D also it can communicate with the machine in its place using a laptop. Currently, personal mobility is available via the Internet. A user can access the web from different machines located in different countries and access to e-mail him. Cell system extends this facility so that the user can use any mobile device to reach the Internet.

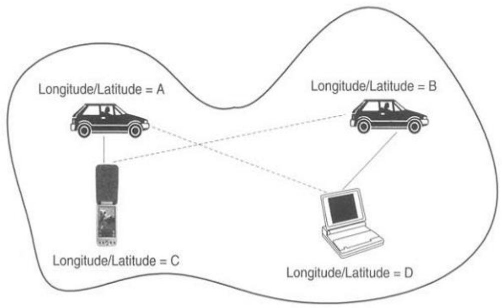

Figure 3. Personal mobility

In this section we talked about historic facts and disciplines of mobile equipment to give the users the clear idea how it works. Development always can be viewed in terms of analogue and digital and aspects of data transmission also. The first-generation wireless technology which was essentially analog is commonly referred to as first generation (1G). 1G systems were deployed only in the business world in 1980. Mobile phones and wireless are introduced and analog standards were defined. A number of wireless communication companies such as Nokia (Finland), Motorola (US), and Ericsson (Sweden), to name a few, established their strong hold in the communication market. The popularity of mobile technology users motivated analog to present new demands on the system and soon 1G infrastructure limitations became known. In early 1990, therefore, the second (2G) mobile technology production was introduced which was based on digital transmission. Digital technology provided high capacity communication and better access. This marked the introduction of the Global System for Mobile Communication - Group Special Mobile (GSM). GSM was originally confined to Europe gradually spreading its standard for most other countries of the world. 2G mobile units can amount to not only send voice, but limited data. Now we have the latest technology such as 3G and 4G which is known as LTE. It is the best technology of communication through mobile, because we can access on our data with a high speed and we can retrieve our database information despite the capacity of our data.

2.2. Data processing and mobility

In recent years the work has become more dynamic with the introduction of "movement in action" ([12], [13], [15]). The concept of "continuous connection to the mobile space" allows workforce that actively performs the required tasks independent of its statutes (mobile or static). This is especially true for information management activities, such as: accessing database, performing transactions, sending and receiving e-mail, web browsing, online shopping, and so on. Personal mobility and terminal mobility have become essential components of the workforce more effectively. It has become a common approach to turn any place or office work. So a manager, while traveling in a car or on a plane or sitting on a beach, can create his office job and may have access to the information necessary to complete his tasks. It is quite clear that this type of work environment provides increased productivity because travel time becomes available for fulfilling the tasks at hand. For example, in the plane manager can supervise the activities of its employees can assess their performance, decide and finalize their pay raises next leg of his plan to travel, and so on. Recent advances in wireless technology has made possible to achieve "continuous connectivity in the mobile space". Technology has managed to provide the convenience of the mobile phone, wireless web browsing, and using e-mail facilities ([16],[13]). Wireless networks are widely used in a business environment to connect laptops and other portables and has significantly increased the functionality of mobile devices. Laptops can now easily store and process data in databases which was possible only by stationary servers. PDAs power and capacity are constantly growing, and they can perform a number of task of database. As a result, more users and more have started using wireless handheld devices not only to communicate with each other, but also to manage the activities of day-to-day operation of their information. These ways of interacting acted on the business world to which is now identified as "Mobile Commerce" (M-Commerce). Above examples illustrates the importance of the system database to manage mobile real-life activities of information processing. Mobile systems, however, cannot function without the support of conventional systems. In conventional systems data is a common characteristic: all components, especially the processing units are stationary. A user must go to a certain place to use the system. In distributed systems, depending on the type of data, data distribution can migrate from one node to another, but this movement is deterministic, that is to move data from a particular source to another destination assigned. Such data migration will not hear any mobility requirements.

3. Transaction management in mobile database systems

The database which operation can be collected together to create a unit of carrying out instructions is called transaction ([16], [17]). A transaction is nothing else just a legitimate execution of database operation. The purpose of transaction is to transform database from one coherent condition to another condition. Each transaction result has to be saved on database in order to be completed in successful way. If there is any interrupt of transaction for any reason then we have a re-execution of transaction and a termination of previous execution. This operation doesn’t affect in other transaction condition, while they are being executed concurrently. In addition at the end the transaction must provide a valid state and must provide a successfully completion. In mobile environment hosts are endlessly moved from one location to another location. Therefore mobile transactions provide information from a storage device even if it is in connected or disconnected station. In mobile environment the most important issue is bandwidth because the location changes constantly by mobile host. In addition if we provide high bandwidth we can access our information easy and it is known as strong connection mode, but if bandwidth is low then we have a weak connection mode. The priority of mobile transaction is that depending on the bandwidth mode it can switches from strong connection to weak connection or conversely. This allows a mobile user to start transactions from anywhere and at any time and maintaining consistency guarantees for their execution. Next we will describe some existing transactions which are able to perform an efficient way of supporting mobile transaction management.

3.1. Mobile transaction models

In this section we describe mobile transaction models, while traditional transaction models do not have the skill to with other challenging requirement of mobile transaction, such as confront with disconnection and supporting the mobility of transaction. In addition there are many transaction models which are created to support mobile transaction. Next we describe few of these transactions which support mobile transaction. First for each model we describe the model and its properties, second we show how the model handles the mobility of transactions and deals with disconnections, and finally we show how it supports distributed transaction execution between mobile and not-mobile hosts.

3.1.1. Report and Co-transaction model

Description. Report and Co-transaction model is proposed by P. K. Chrysan. It is nothing else just the collection of the sub transactions either nested or open nested transaction model. Parent transaction which supports child transaction for being adaptable than atomic transactions is known as nested transaction, it doesn't share the information between parent and child transaction while transaction are being executed [17]. TR is reporting transaction, M is top-level transaction. Reporting transaction TR shares its fractional results to top-level transaction M by delegating its operations. Co-transaction is a reporting transaction but it is blocked during the delegation process. Thus, co-transaction resumes the execution after delegation process is completed.
Transaction properties. Top-level transaction M is the unit of control, and atomic transactions are compensable transaction. A report transaction TR which is compensable doesn't need to delegate all the committed results to the top-level M when it commits. Otherwise sub-transactions that are not-compensable delegate all committed results to the top-level M when it commits.
Mobility. Mobile support stations have the duty to determinate the locations of mobile hosts. However the model doesn't explain what happen when a mobile host moves from one mobile cell to another mobile cell.
Disconnection. Delegation operations require a strait connectivity between the delegator (Report and Co-transaction) transactions and the delegate transaction (top-level transaction). Thus the disconnection is not supported in this model.
Distributed execution. This model supports the distributed transaction processing between mobile hosts and fixed hosts, and they use network connectivity between these hosts only when they need.

3.1.2. Pre-serialization transaction model

Description. This transaction model is made on top of local database system. Mobile transactions are represented from mobile hosts across global transactions coordinators that remains at the mobile support stations. At each site or node exists a site manager which manages all the transactions which are executed on the node. In this model non-serializable schedules among mobile databases are detected by a special algorithm which is known as Partial Global Serialization algorithm. If the graph that is created is cycle form then schedule is non-serializable and mobile transaction is aborted.
Transaction properties. Local transaction manager manages all sub-transactions of a global transaction. In this model, atomicity is guaranteed by vital and non-vital sub-transactions. If a vital sub-transaction aborts, then its parent is forced to abort too. Otherwise if a non-vital sub-transaction aborts its parent is not required to abort. All the results are made visible to other transactions in this local machine when a sub-transaction commits at local database.
Mobility. This model supports mobility in a well form because of global data structure transfers. Global data structure are transferred from one global transaction coordinator to another as the mobile host moves from one mobile cell to another.
Disconnection. In this model mobile transactions are submitted from a mobile host, and sub-transactions are executed in local database servers. If any disconnection happens for any reason, the global transaction becomes marked as disconnected if and only if the disconnection is planned. Otherwise if the disconnection is unplanned global transaction becomes suspended, and when the mobile hosts reconnects to the mobile support station the global transaction is resumed again.
Distributed execution. As we mentioned mobile transactions are submitted from a mobile hosts, and the complete transactions are distributed across local database servers.

3.1.3. Two-Tier transaction model

Description. This transaction model is also known as Base-Tentative, and is based on data replication scheme. A master copy and several replicated copies are created for each data object. Here we have two kind of transaction, such as: base and tentative. Base transaction created the master copy, and tentative access on replicated object copies. These master versions or copy versions can be cashed on mobile hosts. If the mobile host is disconnected for any reason, the tentative version updates the replicated version, and when the mobile host is reconnected, tentative transactions are converted to base transactions and are re-executed on master copy version. A base transaction must fulfill all acceptable correctness in order to commit, otherwise it aborts.
Transaction properties. After tentative transactions commits locally, all results will be visible to other transactions at that mobile host.
Mobility. This model does not support mobility of transactions.
Disconnection. In this model disconnection are acceptable, because as we mentioned after a mobile host is disconnected for any reason the tentative version are saved locally, and after reconnection these transactions are converted to master versions.
Distributed execution. In this model two execution modes are supported: connected and disconnected. Each transaction is carried out in tentative version when mobile host is in disconnected state, and each transaction is being re-executed after mobile host reconnects.

3.1.4. Moflex transaction model

Description. This transaction is an expansion of Flex transaction model, and is foreseen to support mobile transactions. This model is made on top of multi-database systems. This model transaction has few characteristics but two are the most important: First a moflex transaction consists of compensable or non-compensable sub-transaction is initiated by the mobile host. Second a moflex transaction is accompanied by a set of success and failure transactions, dependency rules, hand-over control rules, and acceptable goal states.

Transaction-properties. Mobile transaction management makes use of two-phase commit protocol to coordinate commitment of the Moflex transaction. The Moflex transaction commits if and only if a sub-transaction have reached at least one of the acceptable goals that we mentioned above. After a compensable sub-transaction commits locally, its results are made visible to other transactions. Otherwise for non-compensable sub-transactions the last mobile transaction management which is known as the end location of mobile plays the role of committing coordinator.

Mobility. This transaction model supports mobility by splitting the sub-transactions. In addition if a sub-transaction is compensable it will be split in two sub-transactions, first will continue and commit in current local database and second will be placed at the new location.

Disconnection. This model doesn't support disconnection and it requires connection between the mobile host and mobile support station in order to execute a process.

Distributed-execution. Transactions are transferred to local database systems at fixed hosts to be carried out there. There is a framework that is used to specify the execution of transactions in mobile environments. The main disadvantage of Moflex transaction model is that may not have the capacity to deal with un-expected situations, because the specification of mobile transactions must be fully specified in advance.

4. Conclusions

In this paper we discussed about mobile transaction management of mobile database. Depending on the dynamic life that is present nowadays, we need to move from one place to another and still have access on our data. As we mentioned this is provided by mobile database and we don't need to be fixed in one place in order to access our data. In our paper we discussed about mobility and its types. The main objective of this paper was focused on mobile database transactions. We discussed about transactions, we described few of them which are considered as one of the most successfully transactions on the mobile database. At the end we as a group can conclude that using these transactions which are offered by mobile databases enables us to ensure that our data are secure, and our transactions are committed successfully.

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Vehbi Ramaj has graduated in "St. Kliment Ohridski" University in Manastir. He holds a PhD diploma in Information Systems from 2010. He is Assistant Professor in University of Peja, type of sector: Education and Research. He is author of many publications and many books in the field of Informatics.

Ylber Januzaj has graduated in the Faculty of Contemporary Sciences and Technologies in South East European University. He holds a MSc diploma in Computer Sciences from 2015, and now he is PhD student in South East European University in E-Technologies program. Currently he is full-type job in a network company, in Kosovo, working as a Network Administrator, and at the same time as a Database Administrator. He has developed many application linked with database, and configured many servers with terabytes capacities.

Ymer Januzaj has graduated the Faculty of Contemporary Sciences and Technologies in South East European University. He holds a MSc diploma in Computer Sciences from 2014. Currently he is full-type job in a network company, in Kosovo, working as an IT director.