Mobile Database Design: A Key Factor in Mobile Computing

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ABSTRACT
In the last couple of years mobile have started playing a significant role in our life as the technologies in the Internet advance. A number of mobile applications and services are already in the market and more are expected to become available in the future. As more demand is placed on mobile devices, it will become critical to properly manage mobile Databases. This paper is an effort to highlight the data management issues of mobile environment. Mobile databases provide flexibility for mobile application to provide information anytime and anywhere. Designing of these databases is critical issue, this paper also discuss these issues and their criticality.

1. INTRODUCTION
Mobile computing refers to the applications and services that individual can use while on move using their mobile devices such as laptops, PDA’s mobiles etc. As the global workforce is becoming mobile so providing mobility to these users is becoming a necessity for these new applications and services. Consumers enjoy the convenience offered by mobile applications such as search for local restaurant, make reservations, getting driving directions, custom weather forecast, emergency assistance etc on their mobiles thus technological advances in mobile computing are helping business connect to their most qualified costumers. Mobile computing environment consist of a fixed network and mobile network. The communication takes place with the help of mobile support station which serves a fixed geographical area(cell), as mobile device moves from one cell to another mobile support station in the first cell hands over control to mobile support station of the second cell. Mobile services and application have to be supported by some sort of database. Factors considered for mobile computing

Some of the anomalous factors, which need to be considered for mobile computing, are:
User time is a highly valuable commodity in most of the business applications, Connection time is the unit of monetary charges is assigned in most cellular systems, therefore should be minimum. Number of bytes, or packets, transferred is the unit of charges is computed in digital cellular systems. Time-of-day based charges may vary based on whether communication occurs during peak or off-peak periods. Energy is limited Often, battery power is a scarce resource and should be optimized.

One of the basic principles of radio communication is that it requires less energy to receive than to transmit radio signals. thus, transmission and reception of data impose different power demands on the mobile host. The advantages are that it allows the autonomous operation of a mobile device during partial and total disconnections and limits the volume of data transferred over limited bandwidth.

2. MOBILE DATABASE
The mobile computing environment involves some sort of communication between central database server which is a powerful computer that hosts large databases and mobile database application platform such as laptop, notebook mobile phones etc. Mobile users access the data residing in a central database through database application. The central database can be accessed by a variety of users that are local, remote or mobile for example if a cell phone user wants to find a restaurant in given area, the mobile application first connect to central database the mobile application retrieves the information on mobile screen. The mobile application need not have to access the central database if the information is stored in mobile database because the user has already accessed the same information earlier. Mobile and central database play a significant role in creating mobile computing environment. The database management for mobile application is a big challenge, the exchange of data take place between the mobile database and central database to keep the mobile database updated. Most mobile come with software to help synchronize the data between the mobile and central database.

Mobile database offers flexibility by providing accessibility to it from anywhere and anytime with the help of mobile device so they require special attention in terms of database design. An effective mobile database design attempts to specify an optimal load between stationary and mobile units. Caching or temporarily storing data at mobile station is closely related to distribution and also requires an optimal balance between mobile and stationary database units. The mobile and central data needs to be robust to ensure round the clock availability to mobile applications and services it is even more critical in emergency assistance and security. A mobile database can be thought as distributed database that resides on mobile device and a fixed network. The central database can be accessed through the network and mobile devices keep all or part of such database. The mobile devices has the capability to manipulate the information contained in the database even while it is disconnected from the central database, it is synchronized with central database whenever the mobile device connects to the network. To keep the data up-to-date requires two way communication mobile databases to central database and vice versa.
MOBILE TRANSACTIONS
The access to the future information system through mobile computers will be performed with the help of mobile transactions however a transaction in this environment is different from the transactions in the centralized or distributed databases in the following ways:

a. The mobile transactions might have to split their computations into sets of operations some of which execute on mobile host while others on stationary host.

b. A mobile transaction share their states and partial results with other transactions due to disconnections and mobility.

c. The mobile transactions require computations and communications to be supported by stationary hosts.

d. As the mobile hosts move from one cell to another the states of transaction, states of accessed data objects and the location information also move.

e. The mobile transactions are long lived transactions due to the mobility of both the data and users and due to frequent disconnections.

The mobile transactions should support and handle concurrency, recovery disconnection and mutual consistency of the replicated data objects.

Mobile transactions should be able to support for fault tolerance because of frequent disconnections by mobile devices. There should be a minimized communication (or chattiness) between server and device because of bandwidth limitations. A mobile transaction should support for interruptions because of bandwidth limitations and weak network connections. It should be able to divide computation between the mobile device and server. There are two reasons for this. The first is because mobile devices have limited memory and computing power, second is the disconnection mobile devices experience. A device must be able to continue work even when divorced from the network. Because mobile transactions can be error-prone and long-lived, ensuring durable transactions has its difficulties as well. Moreover, the traditional two-phase protocols, used for locking and data commitment, can result in a high volume of communication over a narrow wireless channel. Flexibility in transaction can be introduced using workflow concept. Thus, a part of the transaction can be executed and committed independent to its other parts.

Transaction Models

Kangaroo Transaction: It is requested at a Mobile Unit but processed at DBMS on the fixed network. The management of the transaction moves with MU. Each transaction is divided into sub transactions. Two types of processing modes are allowed, one ensuring overall atomicity by requiring compensating transactions at the sub transaction level.

Reporting and Co-Transactions: The parent transaction (workflow) is represented in terms of reporting and co-transactions which can execute anywhere. A reporting transaction can share its partial results with the parent transaction anytime and can commit independently. A co-transaction is a special class of reporting transaction, which can be forced to wait by other transaction.

Clustering: A mobile transaction is decomposed into a set of weak and strict transactions. The decomposition is done based on the consistency requirement. The read and write operations are also classified as weak and strict.

Mobile Database design factors and Process

Few aspects need to be considered in order to achieve the goals of designing the Mobile Database System or MDS. Performance need to be stabilized due to the mobility usage. The design of the MDS should be unobtrusive interface. The MDS should be reliable to fulfill the high expectation of mobile users. Lastly the scalability of the MDS, these includes, everyone will synchronize at the same time. Merge replication, let database engines synchronize the local database that resides on the mobile device with a central database running on a server. Determine how the data will be imported or exported to the driving database on the server as part of the database
strategy. Plan the synchronization strategy as part of the database design phase

4. STEPS TO DESIGN MOBILE DATABASE.
1. **Mobile Platform** Factors that may be considered when choosing a platform include, ease of use, ease of development, ease of communication, ease of deployment, product price, system reliability, product maintainability, communication bandwidth, technical support, and product popularity. It is also necessary to give considerations which kind of wireless communication techniques and network facilities are available to use with mobile applications. For example, which mobile operating system is the best for proper deployment of MDS? Current available mobile and laptop operating system include, Windows 2003/XP/Vista/7, Windows Mobile and PocketPC, Symbian OS 7.x/8.x/9.x, Linux, and Embedded Linux.

2. **Mobile Database** Once the platform has been chosen, an appropriate mobile database management system will need to be selected. At this point, if it is determined that the mobile databases supported on the mobile platform selected earlier do not meet the requirements, and then it may be necessary to select another mobile database or to change to another mobile platform (Yu, W.D. and Sharma, 2007). For example, IBM DB2 Everyplace and Oracle9i Lite (G Jim , 2008). Oracle Database Lite provides a small footprint, SQL-enabled client database for local access to enterprise data by applications on the mobile device. In addition, it features the Mobile Server middleware component that supports scalable data synchronization and centralized management of mobile resources (Oracle.com)

3. **Central Database** The selection of central database is parallel with mobile database selection, because the database needs to coexist in a single system while sharing the data. For example, if the SQL Server for Windows Mobile is used as a mobile database, SQL Server can be used as a central database to ensure interoperability, because both database management systems from the same vendor.

4. **Transaction Model** An appropriate transaction model should be chosen depending on the model characteristics and user preferences. Names among transaction models are available in mobile environment Kangaroo, PRO-MOTION, Moflex, Cluster and Multi-Database.

5. **Optimization Techniques** The compression technique provides the capability to move large amounts of data between the mobile device and the central database server. The compression technique will make the best use of available bandwidth, the data transferred between mobile devices and the central database. This will not only improve the performance, but will also make the bandwidth available to the other users. Mobile devices have limited storage issues, the most frequent used data should be stored to make the best use of available space.

6. **Database Entities** Identifying the database entities and the data is crucial. After the infrastructure related decisions have been made, decisions pertaining to storing the data need to be made.

7. **Entity Attributes** While database entities are being identified, attributes contained in each of those entities will need to be considered. For each of those attributes, the data type and data size also need to be determined.

8. **Entity Relationship Diagram** When the detail database entities and their attributes are finalized, an entity relationship diagram needs to be developed.

Database design process is the most critical part. This step involves making a number of important decisions and the above mention steps earlier plays vital roles in developing successful MDS

**Mobile Database Design Issues and Potential solutions**

a. Mobile application are expected to provide information anytime and anywhere so they should be responsive to user request and due to limited memory of mobile the resources should be handled effectively this can be achieved by placing the related data together and by improving cache hit ratio, special attention should be given to the data type that require large amount of memory. When transferring large amount of information some compression technique can applied to improve the performance. The system should be able to handle peak usage without having major impact on performance.

b. mobile can be used online or offline to data consistency is a major factor so there should be a robust mechanism to planned as well as unplanned disconnection between mobile and central database. For online kangaroo transaction model is used and for offline pro-motion model is used. The mobile client should be able to read and write to any available server which holds consistent data.

c. Data synchronization between central database and mobile devices is very important. Most mobile devices offer some synchronization tools to synchronize data between mobile devices and central databases.

d. While performing mobile commerce, banking it is very important to consider keep personal and account information secure therefore security is a main issue in mobile computing environment. Proper safeguard like encryption mechanism must be established to ensure safety of personal and critical data.

e. Mobile device services should be round the clock so well established strategies should be there to manage database recovery, system failures.

f. The mobile database and the central database have to be synchronized at specific times. The synchronization is implemented in the system software of the mobile database and is performed over the http protocol. Using http has the significant advantage of using a widely available protocol and possibly the disadvantage that its performance may be lower than a proprietary protocol for the database synchronization
operation. The secure http protocol (https) to perform the necessary synchronization operations between the mobile and the central database. https provides Confidentiality of the data that is transferred, Authentication of the server computer, authentication of the client computer. Even though client authentication worked on the mobile platform we did not manage to apply it within the synchronization process of the mobile database.

Routing and Query Processing
The mobile computing poses typical problems from the point of view of routing and query processing. For example, as per the mobile-computing model, the route between a pair of hosts may change over time, if one of the two hosts is mobile. This simple fact may have a dramatic effect on the network level, since location-based network addresses are no longer constants within the system. The mobile-computing model also directly affects database query processing. In the case of distributed query processing, the communication costs play important role in query optimization process while selecting the best method of query evaluation strategy. Mobility results in dynamically changing communication costs, therefore, complicate the optimization process.

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CONCLUSION
Mobile computing is becoming a commonly used communication platform. It provides a cheaper way to get connected and in some cases this is the only way to reach people. Network disconnection is a serious for transaction management in mobile environment. Not only is the processing of the disconnected transaction affected, other transactions may also be affected if they want to access the data items currently locked by the disconnected transaction. Database is a major and critical component of mobile computing environment, the issues like data management, query processing, transaction management, device connectivity, access to limited resources, adapting environment need to be considered while designing mobile databases. Other challenges are also there like backup, concurrency control, response time, security etc.

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