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Data management in Mobile Distributed Real Time Database Systems: Reviews and Issues

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***Abstract*— Recent advances in wireless communication networks and portable computers have led to the emergence of a new research area called mobile computing systems. An important part of the research conducted in mobile computing systems has been done on mobile data management. What make the mobile data management different from the conventional data management are the mobility of the users or the computers connected to the system, and the resource constraints such as wireless bandwidth and battery life. As a result of such distinctive features of mobile systems, the data management techniques developed for conventional distributed database systems may not work well in a mobile environment. Research contributions are required in a variety of areas, such as distribution of data on mobile and/or non-mobile computers, processing of queries and transactions submitted by mobile users, maintaining the consistency of data cached on mobile computers, and so on. Another important issue that needs to be considered in mobile data management is the requirement of processing queries and transactions within certain time limits in order to maintain the temporal validity of the data accessed by those queries and transactions. Our basic objective in this project is a thorough investigation of the issues to develop various types of methods for mobile data management in response to the requirements mentioned.**

***Keywords*— Data management, Mobility, Concurrency Control, Security, Mobile Computing, Mobile Distributed Real Time Databases.**

I. INTRODUCTION

Many current researchers in the mobile computing arena share the same vision: ubiquitous access to information, data, and applications. Ubiquitous access refers to the ability of users to access these computing resources from almost any terminal. The idea behind the research is to provide dissemination of larges amount of useful and needful information to different mobile user by designing the efficient data management policies. Recent developments relating to the Internet are establishing solid foundations for wide-area ubiquitous computing systems. [1, 2]

Universal access and management of information has been one of the driving forces in the evolution of computer technology. Central computing gave the ability to perform large and complex computations and advanced information manipulation. Advances in networking connected computers together and led to distributed computing. Web technology and the Internet went even further to provide hyper-linked information access and global computing. However, restricting access stations to physical locations limits the boundary of the vision. The real global network can be achieved only via the ability to compute and access information from anywhere and anytime. This is the fundamental wish that motivates mobile computing. This evolution is the cumulative result of both hardware and software advances at various levels motivated by tangible application needs.[3] Infrastructure research on communications and networking is essential for realizing wireless systems. Equally important is the design and implementation of data management applications for these systems, a task directly affected by the characteristics of the wireless medium and the resulting mobility of data resources and computation. Although a relatively new area, mobile data management has provoked a proliferation of research efforts motivated both by a great market potential and by many challenging research problems. [4]

The focus of Data Management for Mobile Computing is on the impact of mobile computing on data management beyond the networking level. The purpose is to provide a thorough and cohesive overview of recent advances in wireless and mobile data management. Data Management for Mobile Computing provides a single source for researchers and practitioners who want to keep abreast of the latest innovations in the field. [5]

Further evolution of Internet technologies will yield a wide-area network based on component-oriented, dynamic applications, which will support efficient, scalable resource sharing for a large number of mobile and nomadic users. As users gradually grow to rely on the Internet as an indispensable tool, most users will become mobile or nomadic users, or both. While mobile users access the Internet from a portable computer, nomadic users may move from terminal to terminal. In either case, a user would ideally be able to accomplish the same tasks with equal ease from any location either on his portable computer or at any Internet-connected terminal. Many other issues also have in the field of distributed systems, database management, transaction management, operating or file systems, information retrieval or dissemination, and web computing.

II. DATA MANAGEMENT ISSUES IN MOBILE AND PEER TO PEER ENVIRONMENTS

Mobile computing is a revolutionary technology, born as a result of remarkable advance in the development of computer hardware and wireless communication. It enables us to access information anytime and anywhere even in the absence of physical network connection. More recently, there has been increasing interest in introducing ad hoc network into mobile computing, resulting in a new distributed computing style known as peer-to-peer (P2P) computing. In this paper, we discuss the data management issues in mobile and P2P environments.[6,7 The use of wireless communication makes the data availability the most important problem here, so we focus on the problem of data availability and provide detailed discussion about replicating mobile databases. Not only that, we extend our discussion to mobile-P2P environment. At the

end, we discuss the general data management issues in P2P environment. To design efficient data management policies to support the dissemination of large amount of information to different mobile users are the big issues.[8,9]

III. DATABASE CONCURRENCY CONTROL

The work in distributed systems relies upon exploiting or further development of concurrency control techniques. The current approach is to aim for loosely coupled systems rather than the tightly couple client/server paradigm traditionally used. The expansion of interest in web services is fully incorporated into the research work. All topics from the field of database technology and theory are of interest for the Ph.D. Work including the transfer of database technologies, algorithms and theories to new problem domains. These topics include which are not limited to describe topics only. Some common topics which are interest to research work are as following.

* Advanced Query Processing and Optimization
* Ambient-aware Database Applications
* Approximate Queries
* Authorization and Security
* Autonomic Databases
* Biological Databases and Bioinformatics
* Component-based Information Systems
* Constraint and Rule Management
* Data Integration and Provenance
* Data Management in Computer Games
* Data Mining and Knowledge Discovery
* Data Models and Database Design
* Data Warehousing and OLAP
* Knowledge Management Systems
* Geographic Information Systems
* Medical Databases and Data Management
* Mobile Computing and Databases
* Multimedia Databases
* Parallel and Distributed Databases
* Query Languages and User Interfaces
* Real-Time Database Systems
* Scientific and Statistical Databases
* Text Storage and Retrieval
* Transactions and Recovery
* World-Wide Web and Databases

The rapid advancements of wireless communication technology and computer miniaturizing technology have enabled users to utilize computing resources anywhere in the computer network. For example, you can even connect to your Intranet from an airplane. Mobile database are the database that allows the development and deployment of database applications for handheld devices, thus, enabling relational database based applications in the hands of mobile workers. The database technology allows employees using handheld to link to their corporate networks, download data, work offline, and then connect to the network again to synchronize with the corporate database. For example, with a mobile database embedded in a handheld device, a package delivery worker can collect signatures after each delivery and send the information to a corporate database at day's end.[10]

Mobile computing has proved useful in many applications. Many business travellers are using laptop computers to enable them to work and to access data while travelling. Delivery services may use/ are using mobile computers to assist in tracking of delivery of goods. Emergency response services may use/ are using mobile computers at the disasters sites, medical emergencies, etc. to access information and to provide data pertaining to the situation. Newer applications of mobile computers are also emerging.[11]

One of the issue relating to wireless computing is that creates a situation where machines no longer have fixed locations and network addresses. This may complicate query processing for the cases where location plays a key role, since it becomes difficult to determine the optimal location at which to materialize the result of a query. This may happen only for the cases where the location of the user is a parameter of the query. For example, If a traveller information system provides data on hotels, roadside services, etc. to motorists; queries about services that are ahead on the current route must be processed based on knowledge of the user's location, direction of motion, and speed.

Another issue relating to mobile computing is the energy (battery power). It is a scarce resource for mobile computers. This limitation influences many aspects of system design. Can we reduce the requirements of data transfer for the sake of energy efficiency? Yes, by doing scheduled data broadcasts, we may reduce the need for mobile systems to transmit queries. But on the other side it will increase the amount of data residing on machines administered by users, rather than by database administrators. In addition, these machines may, at times, be disconnected from the network; thus, raising the question about the consistency of data.[13]

Today, competitive pressures, changing market conditions, and the availability of mobile and wireless services for the first time are forcing businesses to shift automated business processes into the mobile workforce. Managing the complexities of the mobile workforce and their need for mobile applications requires a platform specifically designed for the task. Building an integrated platform to manage these complexities demands a scalable, robust environment providing the following fundamental services: data management, connection management, integration management, system administration, mobile application development, and production-quality mobile services.

IV. DATA MANAGEMENT

Today’s mobile applications require more than simple data synchronization. They require a complete set of data management services, including strong data modelling, mobile and server-side support for schema deployment and versioning, rules-based data distribution, bi-directional data transfers that are fast and secure, mobile device-based database services, and tight transaction-level integration with multiple enterprise information sources.

The mobile computing environment is observed as a distributed computing. The complete database may be distributed among wired components as in mobile switching stations. This is one approach. But in next approach the entire database is being distributed in wired and wireless components of the computer systems. Some of the parameters that influence and complicate database management are design of database and replication of database.

Design of database – The mobility of clients (host-MH) and disconnection between hosts and servers is very difficult

to predict. In addition to this the dynamic nature of constantly changing location has to be updated carefully and is also adds more complexity to system design.

Replication of data- In mobile computing the data is partially replicated in different places and the availability of these duplicate updated periodically. There is also consistency management and version control available.

Data management for mobile wireless networks is really a challenging task. The challenges of data management system includes

- How to ensure data availability in spite of disconnections.
- How to manage weekly connected mobile wireless links between clients and server.
- How to support constant resources availability to complete the applications.

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V. MOBILE APPLICATION DEVELOPMENT

A mobile application platform should provide developers with an abstraction layer, shielding them from the intricacies imposed by the wireless and mobile computing phenomena. Mobile application development should leverage existing developer training and software source code libraries. Furthermore, mobile interfaces and integration into industry standard development environments (Microsoft Visual Studio, Metrowerks CodeWarrior, Satellite Forms) enables developers to quickly and easily craft rich mobile applications valuable of production use.

individual job roles and responsibilities, along with the appropriate mobile computing platform to perform the job, dictate how application software is designed and built. Finally, mobile applications must process only the essential subsets of mission- critical information and date from multiple back-end sources. The blending of data, device and application functionality presents considerable challenges for the developer of mobile applications.

VI. A MODEL OF MOBILE COMPUTING

The mobile-computing environment consists of mobile computers, which are referred to as mobile hosts, and a wired network of computers. The communication between the Mobile hosts and the wired network takes place through the computers referred to as mobile support stations. A mobile support station manages the mobile hosts within its cell. But what is a cell? A cell is defined as the geographical area covered by a mobile support station. Mobile hosts may move between cells, thus, necessitating a transfer of control from one mobile support station to another. Since mobile hosts may, at times, be powered down, a host may leave one cell and re-materialize later at some distant cell. Therefore, moves between cells are not necessarily between adjacent cells. Within a small area, such as a building, Mobile hosts may be connected by a wireless local-area network within a small area, which may provide lower-cost connectivity than a wide- area cellular network. This will also reduce the overhead of transfer of control.

It is possible for mobile hosts to communicate directly without the intervention of a mobile support station. However, such communication can occur only between the nearby hosts. The size and power limitations of many mobile computers have led to alterative memory hierarchies. Flash memories may be used in such systems to save power. If the mobile host includes a hard disk, the disk may be allowed to spin down when it is not in use, to save energy.

VII. WIRELESS MOBILE COMPUTING

The necessary networking infrastructure for wireless mobile computing combines various wireless networks including cellular, wireless LAN, private and public radio, satellite services, and paging. Wireless networks communicate by modulating radio waves or pulsing infrared light. Wireless communications add new challenges in several areas of distributed computing.

1) Disconnections and Low Connectivity

In general, wireless networks are more expensive, offer less bandwidth, and are less reliable than wire line networks. Consequently, network connectivity is often intermittent: there are

short periods of bursty connections followed by network disconnections. Such network disconnections are either forced by external factors, such as unavailability of the communication signal, or voluntary for example to save cost or energy.

Distributed software systems are usually built without taking into consideration disconnections; they fail to operate when a disconnection occurs. Coda is a good example of a file system that handles disconnections. To support disconnections, either periodically or when a network disconnection is anticipated, data items are cached at the mobile device to allow its autonomous operation during disconnection. Preloading data to survive a forthcoming disconnection is called hoarding. A critical issue during hoarding is how to anticipate the future needs for data. While disconnected, the mobile unit can use only local data. All updates are locally maintained. Upon reconnection, any updates performed at the mobile host are reintegrated with updates performed at other sites, while any conflicting updates are somehow resolved.[29]

Weak connectivity is the connectivity provided by networks in which connection is often lost for short periods of time, is slow or expensive, making prudent use of bandwidth necessary. To handle weak connectivity, various optimizations have been proposed such as selective servicing of cache misses, compression techniques, background re integration of local updates, as well as compromising the quality of data provided to the mobile client.

VIII. CONCLUSIONS

To deal with the characteristics of mobile computing, especially with wireless connectivity and small devices, various extensions of the client/server model have been proposed. Such extensions advocate the use of proxies or middleware components. Proxies of the mobile host residing at the fixed network, called server-side proxies, perform various optimizations to alleviate the effects of wireless connectivity such as message compression and re-ordering. Server-side proxies may also perform computations in lieu of their mobile client. Proxies at the mobile client undertake the part of the client protocol that relates to mobile computing thus providing transparent adaptation to mobility. They also support client caching and communication optimizations for the messages sent from the client to the fixed server. Finally, mobile agents have been used with client/server models and their extensions. Such agents are initiated at the mobile host, launched at the fixed network to perform a specified task, and return to the mobile host with the results.

Another concern in terms of software architectures is adaptability. The mobile environment is a dynamically changing one. Connectivity conditions vary from total
disconnections to full connectivity. The resources available to
mobile computers are not static either, for instance a "docked" mobile computer may have access to a larger display or memory. Furthermore, the location of mobile elements changes and so does the network configuration and the center of computational activity. Thus, a mobile system is presented with resources of varying number and quality. Consequently, a desired property of software systems for mobile computing is their ability to adapt to the constantly changing environmental conditions.

Despite the complete challenges and stress that mobile and wireless computing places on organizations are quickly developing strategies for their mobile workforces. Location- dependent information services have great promise for mobile and pervasive computing environments. They can provide local and non local news, weather, and traffic reports as well as directory services. Before they can be implemented on a large scale, however, several research issues must be addressed. The scope of this paper is to raise the data management in terms of operation and management of application software and management services within the mobile distributed systems and the impact of advanced computing and networking technologies on management.