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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.

A. Connection Management

Today, mobile connection management is technically complex and esoteric, and it varies widely as you travel across the globe. Newcomers to mobile computing must wrestle with the plethora of emerging communication protocols, standards, and low-level operational aspects of wireless connectivity. However, a mobile platform should provide the ability to seamlessly service multiple connection methods, wireless connectivity service options, and handheld device types at the same time. Load balancing and scalability options should be provided to handle volume and frequency spikes as they occur, and connections between mobile devices and the enterprise should be secure, efficient and extremely reliable.

B. Integration Management

In a mobile platform approach, integration management services provide flexible and robust methods for tying into multiple back-end information sources. The requirement for data transformation and business data processing before entry into the back-end source is a key issue. Perhaps the most important aspect of integration management from the mobile platform perspective is the ability to extend the investment made in large corporate information systems to the mobile workforce in an efficient, transparent and meaningful way. To the mobile worker, their mobile interface into the corporate computing world is simply an automation of previously revered pencil and paper-based procedures.

C. Memory Management

A cache is a smaller and fast memory used for holding frequently used data items. The data caching is important in mobile computing environment because these environments has only narrow bandwidths. Data caching is for improving data availabilities and to access latencies in the system so that improves overall performances. For wireless networks the pull-based mode is not suitable for push-based information system considers the cost of cache miss. For architecture based wireless networks the push-based techniques are not suitable. An important metric to analyse cache management algorithms is the hit ratio. In mobile computing environment the hit ratio is not the only metric for evaluating compute cache management algorithms. The caches miss cost on data timing and data size.[27]

D. Location Management

Since the location of distributed components is not fixed, identifying their current location is necessary to contact, use or invoke them. Solutions to the problem of locating or tracking mobile objects vary depending on the application domain. In general, such solutions rely on a combination of storing some information about the location of the objects at selected sites and on performing some form of searching. To locate a mobile object, the stored information about its location is retrieved. Such information may be unavailable, out-of-date or approximate, thus to track the object, its actual location must be found by searching or performing appropriate estimations. Searching may take the form of selective broadcasting at all potential sites or gradually contacting sites from the one most possible to currently host the mobile object to the less possible one.[12]

Several data structures have been proposed for storing the location of moving objects. One approach is to store the location of all moving objects in a single centralized spatial database. Every time the location of an object changes, this central database needs to be updated. To handle the high update rate in such databases, the location attribute is often represented as a function of time and thus is automatically updated with time without an explicit database update operation. Representing location as a function of time is possible, when objects follow pre-defined routes as is the case of vehicles moving in a highway. Such representations may also provide estimations for the future location of the objects.[26]

Changing location also has important implications in distributed system design. Distributed systems have configurations that are no longer static. Thus, distributed algorithms and protocols can not rely on a fixed topology. Moreover, the center of activity, the system load, and locality change dynamically.

The distributed data management meets several challenges due to various characteristics of the wireless networks. There are tow types available in mobile wireless networks they are Architecture-based mobile and Architecture less mobile wireless networks. In most cases when compared to wired links have low bandwidth. The wireless links are subject to disconnections frequently and it would lead to weakly connected links. Hence the mobile are often disconnected from their respective data servers.

E. System Administration

As mobile devices and business applications are deployed into production use, centralized administration and control of users, devices, applications and corporate data becomes a critical requirement. Ramping up to hundreds and thousands of mobile users applies pressure on the distributed server configurations, device management, and communications methods used to support them. Unlike the high-bandwidth, connection-dependent desktop world, mobile system administrators must take into account a variety of uncomfortable factors: slow communication links, unpredictable user connection rates, near real-time information requests, mobile application version control, and mobile application uptime.

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.

A. Wireless Web

Due to the immaturity of mobile products and services, combined with multiplicity of handheld devices, operating systems, form factors, connectivity options, and input methodologies, the web-centric notion of write-once, run anywhere is an alluring concept to explore. Unfortunately, it is simply a fallacy in the mobile world. At its core, web computing implies thin-client, browser-based interfaces operating in highly connection-dependent scenarios. Although the Internet and wireless web access philosophically represents the ultimate destination in client/server computing, mobile computing forces developers, administrators, and users to reach a compromise to support operational characteristics such as unfettered device usage, job-specific information and data access, and fully autonomous, application-driven automation.

Unfortunately, the end result of using a tools-based approach still implies building, maintaining, and supporting infrastructure. The technologies mentioned above have no common interfaces among them. This translates into a constant building/re-building exercise that is expensive for IT organizations and has no measurable return on investment.

B. Mobile Challenges and Demands

Computing in a mobile environment poses significant challenges in four distinct areas: Devices, Users, Applications, and Infrastructure.

1) Mobile Devices

Mobile devices vary dramatically from desktop and laptop computers. Handhelds and mobile devices appear in a variety of form factors and processor types. Screen sizes are quite different, input methods range from stylus and touch screen to barcode. The limitations in disk space, resident memory, and battery capacity exert considerable restrictions on the mobile applications development process. Yet, perhaps the most significant factor that differentiates handhelds from desktops is the intermittent connectivity to back-end business systems and the maze of connectivity options—wireless, LAN, dial-up, docking, and Internet. When moving to mobile, all of these factors make the mobile and handheld platform a considerable challenge.

2) Mobile Users

The mobile workforce represents an entirely new class of enterprise users. The mobile user is accustomed to rugged or isolated environments where weather conditions or connectivity coverage vary greatly. Furthermore, mobile workers are often technologically-challenged and unwilling or unable to perform local systems administration. Features such as instant-on and highly-tuned, task-specific applications are critical business requirements when deploying to mobile users.

3) Mobile Applications

Compared to commercially available applications, mobile applications are unique in a number of ways. Developers designing and building mobile applications cannot make any assumptions about connection types or how often users will connect. In addition, 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.

4) Mobile Infrastructure

The challenge of building an infrastructure to manage mobile devices, users, and applications is more multi-layered than the desktop. Dealing with operational issues such as device connectivity, connection optimization, data and application versioning, tight security profiles, data modelling and management, and applications development in today's environments requires highly specialized personnel with expensive skill sets. Centralized administration and control of the mobile infrastructure is essential in this heterogeneous environment.

Resource availability refers to battery power at the mobile node. The problems of limited power at mobile node has to be manage carefully. This is a important criteria how to minimize the use of resource consumption both in term of bandwidth and energy.

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.

2) Asymmetric Communications

In the case of many wireless networks, such as in cellular or satellite networks, communication is asymmetric. In particular, server machines are provided with a relative high-bandwidth wireless broadcast channel to all clients located inside a specific geographical region. Furthermore, in general, it costs less to a client in terms of power consumption to receive than to send. These considerations favor push-based delivery. In traditional client/server systems, data are delivered on a demand basis. A client explicitly requests data items from the server. This is termed pull-based delivery. In contrast, with push-based data delivery, the server repetitively broadcasts data to a large client population without a specific request. Clients monitor the broadcast and retrieve the data items they need as they arrive on the broadcast channel.

Asymmetric nature of wireless communication link is another challenges for data management, I wireless links to ensure low resource consumption and data latency. The mobile wireless environment has another characteristics to address is location and time dependant nature. To maintain location-dependant and time-dependant information some efficient techniques such as cache invalidation and pre-fetching, has to be used in mobile wireless networks.[28]

Device Constraints

In wireless mobile computing, to be portable, devices must be small, light and operational under wide environmental conditions. Also, in the context of ubiquitous or pervasive computing, computational power is embedded in numerous small devices. Portable devices have small screens and small, multifunction keypads; a fact that necessitates the development of appropriate user interfaces. Portable or embedded devices have fewer resources than static elements, including memory, disk capacity and computational power than traditional computing devices. Portable devices rely for their operation on the finite energy provided by batteries. Even with advances in battery technology, this energy concern will not cease to exist. The concern for power consumption spans various levels in hardware and software design. There are higher risks to data in mobile devices, since it is easier for mobile devices to be accidentally damaged, stolen, or lost. An additional issue is scalability. The number of portable computing devices is in the order of billions. Storing and managing information in such systems is a formidable task.

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.

REFERENCES

[1] Jensen, C. S. Research Challenges in Location-enabled M-services. In Proceedings of the 3rd International Conference on Mobile Data Management (MDM'02), 2002.

[2] Pitoura, Evaggelia, Samaras, George, "Data Management for Mobile Computing, Advances in Database Systems, Vol 10, 1998, pp-172.

[3] T. Imielinski and B. R. Badrinath, Wireless Mobile Computing: Challenges in Data Management, Communications of the ACM, 37(10), 1994, pp18-28.

[4] E. Pitoura and G. Samaras, Data Management for Mobile Computing, Kluwer Academic Publishers, 1998.

[5] Budiarto, Nishio, S., Tsukamoto, M. "Data management issues in mobile and peer-to-peer environments", Data & Knowledge Engineering, (c) Blue rejoins Volume 41, Issue 2-3, 2002, pp 183-204.

[6] Margaritis, M., Fidas, C., Avouris, N., and Komis, V. (2003). "A Peer- To-Peer Architecture for Synchronous Collaboration over Low-Bandwidth Networks", in K. Margaritis, I Pitas (ed.) Proc 9th PCI , Thessa- loniki, 2003.

[7] Leontiadis, E., Dimakopoulos, V. V., and Pitoura, E. Cache Updates in a Peer-to-Peer Network of Mobile Agents. In Proceedings of the 4th IEEE International Conference on P2P Computing (P2P'04), 2004.

[8] Wang, C., Xiao, L., Liu, Y., and Zheng, P. Distributed Caching and Adaptive Search in Multilayer P2P Networks. In Proceedings of the 24th Int. Conference on Distributed Computing Systems (ICDCS'04), 2004.

[9] Tao Ye, H.-Arno Jacobsen, and Randy Katz. Mobile awareness in a wide area wireless network of info-stations. In MobiCom '98: Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking, New York, NY, USA, ACM Press, 1998, pp 109-20.

[10] Alfredo, Arantza, Mobile Computing:data Management Issues, 2000.

[11] E. Pitoura and G. Samaras, Locating Objects in Mobile Computing, IEEE Transactions on Knowledge and Data Engineering, To appear.

[12] L. Golab and M. T. Ozsu. Issues in data stream stead of the validating transaction, the conflicting transaction management. SIGMOD Rec., 32(2), 2003, pp 5-14.

[13] Mohan, C, Lindsay B and Obermark, Transaction Management in the R* Distributed Database Management Systems, A CM TODS, 11(4)., 1986.

[14] Oszu M, Valduriez P, Principles of Distributed Database Systems, Prentice-Hal, 1991.

[15] Kohler W, A survey of Techniques for Synchronization and Recovery in Decentralized Computer System, ACM Comp uting Surveys, 13(2), 1981.

[16] Nystrom D, Nolin M, Pessimistic Concurrency Control and Versioning to Support Database Pointers in Real-Time Databases, Proc. 16th Euromicro Conf . on Real-Time Systems, 2006.

[17] Ramamritham,Son S. H, and DiPippo L, Real-Time Databases and Data Services, Real-Time Systems J Chi-Jiun Su and Leandros Tassiulas. Joint broadcast scheduling and user's cache management for e□cient information delivery. In MobiCom '98: Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking, New York, NY, USA, ACM Press, 1998, pp 33-42.

[18] Swarup Acharya. Broadcast Disks: Dissemination-based Data Management for Asymmetric Communication Environment. PhD dissertation, Department of Computer Science, Brown University, USA, May 1998.

[19] Amadio, R.M., An asynchronous model of locality, failure, and process mobility. Proc. CO-ORDINATION 97, Lecture Notes in Computer Science 1282, Springer Verlag. 1997.

[20] ., vol. 28, 2004, pp 179-216.

[21] Robert A and Garcia-Molina H, Scheduling Real-Time Transactions, ACM Trans. on Database Systems, 17(3), 1992.

[22] Levy E., Korth H and Silberschatz,, An optimistic commit protocol for distributed transaction management, Pro.of ACM SIGMOD Conf , 1991.

[23] Jayant. H, Carey M, Livney,1992, "Data Access Scheduling in Firm Real time Database Systems", Real Time systems Journal, 4(3).

[24] Jayanta Singh and S.C Mehrotra, ,"Performance analysis of a Real Time Distributed Database System through simulation" 15th IASTED International Conf . on APPLIED SIM ULATION & MODELLING, Greece, 2006.

[25] Jayant H. "Transaction Scheduling in Firm Real-Time Database Systems", Ph.D. Thesis, Computer Science Dept. Univ. of Wisconsin, Madison, 1991.

[26] Jayant H., Ramesh G. Kriti.R, S. Seshadri, "Commit processing in Distributed Real-Time Database Systems", Tech. Report-TR-96-01, Pro. Pro. Of 17th IEEE Real-Time Systems Symposium, USA,1996.

[27] Jan Lindstrom, "Relaxed Correctness for Firm Real-Time Databases," rtcsa,pp.82-86, 12th IEEE International Conf erence on Embedded and Real-Time Comp uting Systems and Applications (RTCSA '06)., 2006

[28] Jensen, C. S., Kligys, A., Pedersen, T. B., and Timko, I. Multidimensional Data Modeling for Location- based Services. VLDB Journal, 13(1), 2004, pp 1-21