PRAGMATIC REVISION ON DIVERSE MOBILITY MANAGING PATTERNS

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Abstract

An important issue in the design of a mobile computing system is how to manage the real-time locations of mobile clients. Now-a-days the existing schemes like POFLA, UPBLA, MIPN are not scalable and not suitable to the new mobile computing applications. Here a new dynamic history based structure is proposed in which the location information of the mobile clients within a cell is managed by the reporting cell. The mobility pattern, which are stored in various cells are used for searching mobile clients. All the existing schemes have the problem of heavy location update overhead and long search delay hence these are not suitable to the system which is supporting real-time queries.

The main aim of this paper is to appraise the performance of various existing systems used for mobile location identification. The total cost of the above three existing systems is compared with our new system based on mobility pattern. The total cost can be measured in terms of total number of data routed for a particular period of time, total number of registration time and location time taken to access a data with CMR. Various factors used to measure the performance are call-to-mobility ratio, locating time ratio, the update cost ratio, time-data routed ratio. This cost can be computed and evaluated in three types of distributions viz uniform distribution, linear distribution and exponential distribution to find whether there is any deviation. During majority of the operations, the newly developed scheme is superior.

The performance can be tested by generating random data sets for number of generations from 500 to 1,000, the network size taken was 4 x 4, 6 x 6 and 8 x 8. The new system can be benefitted if number of generations and the size of network are increased. The following are the contributions of this research: Mobility Agent (MA) based on activity rate of user and adaptive paging for location management. Reduced Location Update and Packet Delivery Costs for Fixed Mobility Pattern Mobile Users. Reduce Regional Registration and Data Packets Delivery Costs. Hybrid Location Management Scheme Based on Mobility Pattern of the Mobile User

Keywords*: mobility, registration, updation, history, pattern, CMR, packet delivery.*

Introduction

One of the most important issues in the design of a mobile computing system is location management of mobile clients. In a cellular mobile network, the whole service area is divided into a collection of interconnected *cells*. In each cell, there is a base station which communicates with the mobile clients in the cell. The base stations are connected by a high-speed wired network. The mobile clients may move within their current cells or move into other cells. While a mobile client is moving, the system has to record down its real-time location since other mobile clients may generate queries on the location of the client and may want to communicate with the client.

To efficiently manage the locations, a pattern is defined. Their validity may change rapidly with time especially for the case where the mobility of the clients is high. On the other hand, the queries submitted from mobile clients are always associated with timing constraints on their completion time. In order to provide valid location information to a mobile client and to meet the deadlines of the queries, the issues on how to manage and organize the pattern become important.

In the existing systems, one of the base stations is defined with a location database, called *Home Location Register (HLR)* which maintains the client profiles. In addition, each base station also maintains a *Visitor Location Register (VLR)* to record the mobile clients which are currently within the cell responsible by the base station. When a mobile client moves out of its current cell and enters another cell, a new entry of the client location is added into the VLR of the new cell and then the HRL will be also updated. In locating a mobile client for a query, the VLR of the cell, where the query is initiated, will be searched first. If the client cannot be found in the VLR, a request will be sent to the HLR of the client to find out its location. Once the cell, where the location of the client is recorded, has been identified, polling messages will be sent out in the cell to communicate with the client to ensure that it is the right cell where the client is now residing.

Related Work

Pointer forwarding based Local Anchoring (POFLA)

In this scheme, a Visitor Location Register (VLR) close to a user is selected as the local anchor. Whenever the user moves from one Registration Area (RA) to another, the mobile terminal will perform location update to the local anchor. The local anchor for a mobile user will not change unless a call request arrives and also the Home Location Register (HLR) is updated. The drawback is that when the user keeps moving constantly without receiving any call, the updates to local anchor may become costly too. To make sure the setup delay is under some constraint, a threshold of the pointer chain length is set. The user needs to perform registration to the HLR whenever the chain threshold is reached.

Some VLRs are selected as the Mobility Agents (MAs), responsible for the location management and can be distributed geographically. The MAs with higher level pointers used to minimize the calling setup delay. The low level pointers are set up between the adjacent VLRs and can avoid the possible costly updates to HLR and the traffic congestions in local anchor.

When a user moves from one RA to another, it informs the switch at the new RA about the old RA. It also informs the new RA about the previous MA it was registered. Here it uses two operations viz move and find.

In MOVE operation, the new VLR exchanges messages with the old VLR or the old MA to set up a forwarding pointer from an old VLR to the new VLR. If a pointer is set up from the previous MA, the new VLR is selected as the current MA. It does not involve the user's

HLR. First the user registers at the new RA/VLR, secondly passing the ID of the former RA/VLR and MA; thirdly the new VLR deregisters the user at old VLR; and finally the old VLR sends ACK and the user's service profile to the new VLR;

The find operation is invoked for the subsequent calls to the user from some other switches. Here if the called party is in the same RA then return; If Queried VLR is not the called party's current VLR execute the VLR queries the next VLR in the pointer chain then Actual VLR is found. If the called party's current VLR sends the user location to HLR then HLR sends the user location to calling party's switch.

After processing this strategy, the HLR is updated only every K1.K2 moves (K1 and K2 are the level 1 and level 2 pointer chain length threshold).

The cost for POFLA is

$$C_B \textit{ (Location updation)} = M + F = m/p + F$$

$$C_F \textit{ (Location tracing)} = M' + F'$$

Where **M**: the total cost of all the MOVES between two consecutive calls;

F: the cost of a single FIND;

m - the cost of a single invocation of MOVE;

M': the expected cost of all MOVES between two consecutive calls;

F': the average cost of the Two Level Fwd FIND;

User Profile based Location Anchoring (UPBLA)

In this scheme, the system can predict a user's future location so that resource can be assigned in advance if the user is engaging in some important applications. If the system stores the necessary information in the profile, some system resource can be reserved in advance to provide the user real time service. If the user mobility pattern is known, some specific information can be prepared for a specific user in some specific area. The location list is stored in the switch that will conduct the search for the user. It can reduce the location update cost effectively at the expense of increasing paging cost or paging delay. When users follow the mobility pattern, the location update traffic can be reduced. When user enters A_i at time t_i and the residence time in A_i is t_i, we say the user follows *time-sequence pattern* and the user state is 1. If the user enters and exits location areas following the A_i order in the profile only, then the user follows the *sequence pattern* and the user state is 2. If user does not follow the above two patterns, but $A \in \{ A_i \}$ then the user state is 3. If $A_i \{ A_i \}$ then the user state is 4. So we need to find out how close a user follows mobility pattern.

When a user is in state 1, 2 or 3, no registration or state message needs to be sent if the user keeps the state unchanged. If the user in state 4, the terminal will update its location to the system every time the user enters a new location area. In state 1, 2 or 3, the user needs to send update message only when the states switch.

The mobile terminals for the next generation should incorporate more intelligent functions. When a user roams in the network service areas, the mobile terminal can record the location area ID, location area entrance and exit time. The User Actual Path (UAP) can be used to update the UMP periodically. As the time elapses or user crosses location area boundary, the mobile terminal can tell whether the user is following any pattern or not by comparing the UAP with UMP. The similarity between UAP and UMP can be compared by the measurement distance.

The total cost of this method is more complicated. If we define C_{pi} the paging cost for users in state i and πi the probability that the user is in state i when a call arrives, respectively.

We need to derive C_{pi} to specify the total cost of this scheme. In this method, when *user is in state 1*, if a call arrives, the location area will be paged according to the profile. The user can be found the next location area needs to be paged if no response is received in predefined time in current area. If a *user is in state 2* when a call arrive only the next location areas need to be paged.

Mobility Management in Mobile IP Network (MIPN)

Mobile IP is the mobility-enabling protocol to support global mobility in IP networks. Mobile IP enables mobile terminals to maintain all ongoing communications with the Internet while moving from one subnet to another. This can solve the user mobility in all mobile systems. This can be allowed a mobile node to effectively utilize two IP addresses, one for identification and the other for routing. In the Mobile IP network, mobile terminals can change their points of attachment in different subnets are called Mobile Hosts (MHs). An MH has a permanent address registered in its home agent (HA) and this remains unchanged when the user moves. This address is used for identification and routing purpose. Here the MH can obtain a new IP address from a router in the visited network. The router in the visited networks assigns MH the IP address is the MH's foreign agent (FA) and the new address is the MH's care-of address (CoA) used for packet routing purpose. To maintain continuous services, Mobile IP requires the MHs to update their locations to the HAs whenever they move to different subnets so that the HAs can intercept the packets delivered to them and tunnel the packets to the user's current points of attachment. Thus, the Mobile IP can provide continuous internet access services for mobile users and does provide a simple and scalable solution to user mobility. This is not a good solution for users with high mobility. Its mechanism requires every MH to update its new CoA to the HA every time the MH moves from one subnet to another, even though the MH dose not communicate with others while moving. In this scheme, the location update messages to the HAs can be reduced by setting up a hierarchy of FAs for mobility management, where the level number of the hierarchy is dynamically adjusted on mobility and traffic load.

Here there is no restriction on the shape and the geographic location of subnets. Here, an MH can determine if it enters a new subnet by detecting the agent advertisement messages sent by the mobility agents (HAs or FAs). The MH obtains a new CoA from the new serving FA and sends the location update message to its HA. Upon receiving the message, the HA can set up a binding between the MH permanent address and current CoA so that the HA can intercept the packets to this MH and tunnel them to the user's current access point. The MHs are required to update their new CoAs whenever they change the locations. By this system the location update signaling traffic can be reduced by registering the new CoA to the pervious FA.

The packets for this user can be intercepted and retunneled along the FA hierarchy to the mobile terminal. Thus, the location update traffic can be localized. However, the packet forwarding by multiple FAs will cause some service delivery delay, which may not be appropriate when there is delay restraint for some internet applications such as video or voice services. To avoid excessive packet transmission delay, we set a threshold to the hierarchy level number. When the threshold is reached, the MH will register to its HA. Here, the threshold is adjusted dynamically on every user's current traffic load and mobility.

Mobility Pattern based Scheme (HB)

This system maintains a mobility pattern in each and every visited cell in the network. Here the pattern means the repository which is used to store the full details about the list of location areas to be visited and the visited cells. If the number of pattern is more the updation cost and seeking cost is reduced. By the pattern the mobile system has to verify all the resources from the visited cell. The list is sorted descending on the basis of number of times a cell is visited. By this arrangement, the time taken to access and the path traversed are reduced automatically even Location update is not necessary for certain limits arrived.

Here various formula used in the existing system has been revised to reach the above defined objectives. Here we have updated the cost function of existing location management cost, which contains only the number of location updates and the number of paging performed. Here we have seen that the cost of a location update is usually much higher than the cost of paging-several times higher. *The location update cost* is calculated by interpreting the existing location update cost, the set of reporting cells in the network and the number of reporting cells maintained in the pattern. So we can obtain the least location cost. *The paging cost* is computed by existing location update cost, new location update cost and existing paging cost. And also calculate the total search cost by summing various search operations (search cost for the - location updated users, non-updated users from the same reporting cell, non-updated users from different reporting cell: first call and subsequent calls). Then *total cost* is computed by new location update cost and new paging cost. So the location management cost of a particular reporting cell is minimized. This scheme is an apt solution for dynamically solving the problems in the following four different cases.

When there is no reporting cell in the network; here the entry is new and no other cells are occupied as reporting cell without any history. Here the time taken to access and also the number of paths traversed are same for all the existing schemes.

When there is only one reporting cell: The new entry must refer its history at any cost. There is no guarantee to reduce the time and path.

When there is more than one reporting cell*:* In this case only the defined objectives can be reached with surety of shortest path.

When there is more than one reporting cell having same shortest path*:* The decision taken is definitely confusing. Some special tool must be applied for solving this problem. By finding a proper solution the objectives can be reached definitely but there is no guarantee for minimum time to access. The location information is updated when the user enters to a new reporting cell, which is not in the pattern. As a result, the updation cost is proportionately reduced with the value of entries in the pattern. When there is an increase in the number of reporting cells in the pattern, the location update cost is proportionately reduced.

The *vicinity* of reporting cell is the collection of all the cells that are reachable from a reporting cell without entering another reporting cell. And the *vicinity value* of reporting cell is the maximum number of cells to be searched, when a call arrives for a user whose last location is known to be reporting cell. Whenever a call arrives to the user, the user may be available within the vicinity of any one of the reporting cells in the history.

Due to their popularity and robustness, Genetic algorithm is used to solve the reporting cells planning problem for optimization purpose. Because the solution space to be searched here is huge and also making sequential search computationally more expensive and time consuming. It can be used to find *efficient* solutions in a variety of cases.

User call-to-Mobility Ratio

The CMR of a user is defined as the expected number of calls to a user during the period that the user visits an RA. If calls received by the user at a mean rate λ and the time the user resides in a given RA has a mean $1 / \mu$, then the CMR, denoted as ρ, is given by $\rho = \lambda / \mu$. If CMR is small, the user has relative higher moving rate than call arrival rate and the mobility rate as well as the registration cost will be high; if CMR is high, the paging cost will be dominant and the mobility as well as the registration cost will be low.

Performance Evaluation

- Generally the performance of the pattern based system is good as compared to other existing system.
- For all systems, the time = 2, the data routed are comparatively high.
- In the pattern based system maximum number of data can be routed during time = 2 and minimum data routed during time = 4.

- The UPBLA its shape more or less similar to our new system and this is next to our new system.
- The performance of POFLA is worse than any other system.
- In MIPN, there is an abnormal increase in CMR=4.
- In POFLA, all the CMRs from 1-9 are in increasing trend, CMR=10 is decreasing dramatically.
- All the CMR in all the existing systems are in zig zag manner, particularly the performance of MIPN is in higher zig zag manner.
- The performance of the HB and MIPN are collinear.
- The performance of POFLA and UPBLA are collinear if optimized and update the point where CMR=5;

Conclusion

We clearly prove that this new scheme can significantly reduce the path and time. The results show that this scheme clearly solves the heavy location update traffic problem. This scheme not only satisfies the requirements of the mobile environment but also fulfills the pervasive environment by integrating *intelligence* in the mobile system. By use of this intelligence, the extraction of output and its level of accuracy are very high.

In near future we have proposed to remove the issue of location update while roaming within same reporting cell or outside the reporting cells or out of boundary. The mobile network for implementation will be 10 X 10 and 12 x 12 for improving the level of accuracy.

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