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A Review on various Location Management and Update Mechanisms in Mobile Communication

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ABSTRACT: Mobile computing is a new emerging computing paradigm of the future. Data management and location management in this paradigm poses many challenging problems to the Mobile database community. In the past decade, Mobile communications have experienced an expensive growth due to recent technological advances in mobile networks and cellular telephone manufacturing. Location management is a very important problem among these challenges. It consists of updating the location of the user, searching the location and performing search-updates. When the host changes location, an update occurs. When the host wants to communicate with a mobile host whose location is unknown to the requesting host, a search occurs. A search-update occurs after a successful search, when the requesting host updates the location information corresponding to the searched mobile host. The goal of a good location management scheme should be to provide efficient searches and updates. In this paper, the different location management schemes, various update strategies are discussed.

KEYWORDS: Mobile Communication, Mobile Database, Location Management.

1 INTRODUCTION

Managing location information of mobile nodes is an important issue in mobile computing systems. Location management is one of the fundamental issues in cellular networks. It deals with how to track subscribers on the move and how to update his or her movements. In mobile communication environment, they are going to accommodate more subscribers; the size of the cell must be reduced to more efficient use of the limited frequency spectrum allocation. This will add to the challenge of some fundamental issues in cellular networks. Location management consists of updating the location of the user, searching the location and performing search-updates. Various strategies can be discussed in this paper for the efficient performance of updating, searching and search-updating strategies throughout the execution.

Location server is maintaining the details about mobile user, it consist separate location directory for each MH. Creating a fixed location directory of all the nodes a priori is not a solution. The location directory has to be dynamically updated to account for the mobility of the MHs. The design of a location directory whose contents change dynamically raises important issues.

Some of them are as follows:

- When should the location directory be updated? If the updates are done each time an MH's location changes, the directory will always have the latest location information, reducing the time and effort in locating an MH. However, such a policy imposes burden on the communication network and the location servers, i.e., nodes that maintain the directory,

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- Should the location directory be maintained at a centralized site, or should it be distributed? A central location server has problems with regard to robustness and scalability. Hence, a distributed directory server is referable. This leads us to the next questions.
- How should the location information be distributed among the location servers?
- Should location information about an MH be replicated across multiple location servers? It is not possible to a priori determine the variations in spatial distribution of MHs in the network and the frequency with which node location will be updated or queried. A location management strategy is a combination of search strategy, update strategy and search-update strategies throughout the execution.

2 SYSTEM MODEL

A roaming mobile subscriber, moves freely within the GSM network. Because the network knows the location of the mobile station, it is possible for the mobile subscriber to receive a call wherever he or she is. To keep the system updated with the current subscriber location information, the mobile station must inform the system whenever it changes location area. A location area consists of one or more cells in which a mobile station can move around without needing to update the system on its location. A location area is controlled by one or more Base Station Controller (BSC) but by only one Mobile Services Switching Center (MSC). The BSC sends paging messages to the Radio Base Station (RBS) defined within a certain location area. If the mobile station moves between cells belonging to different location areas, then that network must be informed via a procedure called location updating.

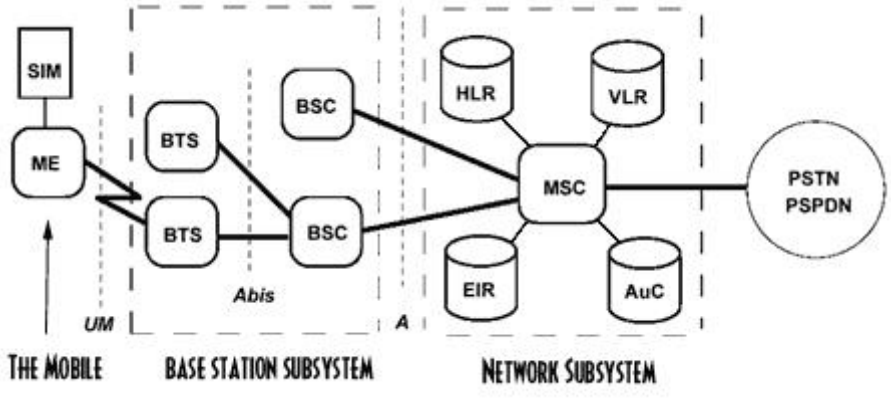

Figure 1 - Logical View of a Mobile Computing System

A mobile host can communicate with other units, mobile or static, only through the mobile service station of the cell in which it is present. If a node wishes to communicate with a mobile host, first it has to determine the location of MH (the cell in which the MH is currently residing). This location information is stored at location servers. Depending on the frequency of location updates, this location information may be current, or out-of-date. Once the location of the MH has been determined, the information is routed through the fixed wire network to the MSS of the cell in which the MH is present. Thus the MSS relays the information to the destination MH over a wireless channel. We assume that MSSs act as location servers. Hence all the MSSs collectively maintain the location directory.

3 MECHANISMS FOR LOCATION MANAGEMENT

Papers can be written in English, French, Spanish or Arabic. The Base Transceiver Station (BTS) of every cell continuously transmits the location area identity on the control channel (BCCH). When the mobile station detects that the broadcast location area identity is different from the one stored in the SIM card, it performs a location update.

If the mobile subscriber is unknown to the Mobile Services Switching Center/Visitor Location Register (MSC/VLR) (that is, the broadcast location area belongs to a new MSC/VLR serving area), then the new MSC/VLR must be updated with subscriber information. This subscriber information comes from the Home Location Register (HLR).

This location updating procedure is described in the steps below and in Figure 2.

- The mobile station requests a location update to be carried out in the new MSC/VLR. The IMSI is used to identify the mobile station. An International Mobile Equipment Identity (IMEI) check is also performed.

- In the new MSC/VLR, an analysis of the IMSI number is carried out. The result of this analysis is a modification of the IMSI to a mobile global title which is used to address the HLR.
- The new MSC/VLR requests the subscriber information for the mobile station from the HLR.
- The HLR stores the address of the new MSC/VLR.
- The HLR sends the subscriber data to the new MSC/VLR.
- The HLR also orders the old serving MSC/VLR to cancel all information for the subscriber because the mobile subscriber is now served by another MSC/VLR.
- When the new MSC/VLR receives the information from the HLR, it sends a location updating confirmation message to the mobile station.

Note: The HLR is not informed if the mobile subscriber moves from one location area to another within the same MSC/VLR serving area.

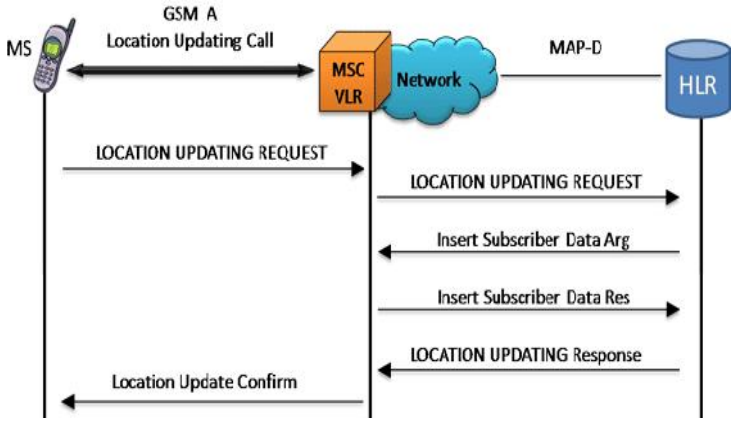

Figure 2 - Location Update Procedure

3.1 LOCATING USER

Location management deals with how to keep track of an active mobile station within the cellular network. In this paper there are two basic operations involved in location management is discussed. These are location update and paging. The cellular network performs the paging operation. When an incoming call arrives for a mobile station, the cellular network will page the mobile station in all possible cells to find out the cell in which the mobile station is located so the incoming call can be routed to the corresponding base station.

A location update scheme can be classified as either global or local, A location update scheme is global if all subscribers update their location at the same set of cells, and a scheme is local if an individual subscriber is allowed to decide when and where to perform the location update. A local scheme is also called individualized or per-user-based. A location update scheme is static if there is a predetermined set of cells at which a mobile station regardless of its mobility must generate location updates. A scheme is dynamic if a mobile station in any cell depending on its mobility can generate a location update. A global scheme is based on aggregate statistics and traffic patterns, and it is usually static too.

In general, it is unnecessary to track locations of all users all the time. Hence, a database, which stores locations of users, will often be imprecise in terms of the exact user's location. For instance, a user's location may only be updated when the user crosses the border between two different areas or zones as opposed to updates on crossing a small cell. This, in general, will save on the number of location updates that the moving user will have to perform but will put an additional burden on the search process if the exact location of the user is sought.

3.2 LOCATION QUERY

A static note, say MSS or a mobile host in the cell corresponding to the MSS, wishing to communicate with the target mobile host first needs to know the location of the target. Let the target mobile host's identity be MH_id. To locate the target, the function locate_MH is invoked. First, MSS searches its cache for MH_id's entry. If such an entry is found the corresponding mobile service station, MSSi, is probed to determine if MH_id is still in the same cell. If so, MSSi returns its own location in the response. Otherwise, one of the virtual identities of MH_id is arbitrarily selected. This virtual identity is

used by the hash function to determine the set of MSSs that should be queried about MH_id's location which is the read set for location information.

If a queried mobile service station, MSSi, has the location MH_id in its directory, it is sent in the response. If no query mobile service station has the location of MH_id, the query is broadcast over the network. Once MSS receives the location of the cell in which MH_id is present the messages sent over the fixed wire network to the corresponding mobile service station. If MH_id has moved out of the cell since the last location update, a sequence of forwarding pointers (depending on the path taken by MH_id since it moved out of MSSi's cell) is followed to the cell in which MH_id is currently present.

3.3 LOCATION MH

The problem at hand is as follows: given an MH, determine the location server (s) that will store the location of the MH. Storing the location information of an MH at only one MSS (serving as the MH's location server) is not desirable due to the following reasons:

- MHs exhibit a spatial locality of reference: even though all nodes in the system can potentially communicate with the network, bulks of the references originate from only a subset of them. The nodes in the working set may be clustered in different parts of the networks. So, to reduce query costs, it is advisable to have location servers for the MH in the vicinity of such clusters.
- Multiple location servers for an MH make the distributed directory tolerant to the failure of some of the servers.

```
Locate_MH(MH_id,MSS)
    {
    int i,j,k;
    if((i=location(MH_id))Elocal cache)
    {
    send(MSSi,QUERY,MH_id);
    wait(response from MSSi);
    if(response==YES)
    return(response.location);
    else
    delete(location(MH_id) from local cache;
    }
    i←any virtual; identity of MH_id;
    j←h(MSS,i);
    for all k E Si do
    send(MSSk,QUERY,MH_id);
    wait(positive response from any MSSk);
    location(MH_id)←response.location;
    if no positive response
    send (broadcast,QUERY,MH_id);
    }
```

When a mobile host moves from one cell to another, its location has to be updated at the appropriate MSSs that act as the distributed location server. The choice of the update strategy (time based, no of movements based, distance based (is referred in the later part)) is orthogonal to the location update procedure. The parameter old_MSS denotes the MSS of the cell in which the mobile host was resident when the last update was done. The current cell's MSS is called the new_MSS. When

a mobile service station with identity MSS_id, or an MH inside the cell corresponding to this MSS wishes to locate an MH whose identity is MH_id, the MSS takes following actions:

```
Assign_virtual_ids(MH_id)
{
int i; boolean found;
VMH_id(MH_id)← {MH_id + x};
i←0; found← false;
while(i<x and not(found))
{
if(assigned[i]=FALSE)
{
assigned[i]←TRUE;          VMH_id←VMH_id(MH_id)U{i};
Found←TRUE;
}
i←i+1;
}
}
VMH_id (MH_id)
```

The set of virtual identities associated with an MH whose identity is MH_id. The MSS of the cell in which the MH is resident maintains this set, on behalf of the MH. When the MH moves from one cell to another, the set is migrated from the MSS of the old cell to the MSS of the new cell.

3.4 LOCATION UPDATE

Upon a move, apart from MSSs involved (i.e., MSS of the source and destination cells), location updates take place in all the LSs located on the path from the MSS of the source and destination cells to the root. The scheme and an example illustrating it follow.

```
Location_update (MH_id, old_MSS, new MSS)
{
int i,j,vmh;
for all vmh E VMH_id(MH_id) do
{
i←h(old_MSS,vmh);
for all j E Si do
send(MSSj, delete, MH_id, old_MSS);
i←h(new_MSS,vmh);
for all j E Si do
send (MSSj,add,MH_id, new_MSS);
}
}
```

4 LOCATION UPDATE STRATEGIES

4.1 TIME BASED LOCATION UPDATE

Given a time threshold T, a mobile station updates is location every T units of time. The corresponding paging strategy is also simple. Whenever there is an incoming call for a mobile station, the system will first search the cell the mobile station last reported, say i. if it is not found there, the system will search in cells i+j and i-j, starting with j=i and continuing until the mobile station is found. The time-based strategy is dynamic in the sense that the cells for reporting are not predefined. The time-based strategy is dynamic in the sense that the cells for reporting are not performed. In time-based strategy a mobile station dynamically determines when to update its location based on its mobility pattern and the incoming call arrival probability. Whenever a mobile station enters a new cell, the mobile station needs to find out the number of cells that will be paged if an incoming call arrives and the resulting cost for the network to page the mobile station. The weighted paging cost at a given time slot is the paging cost multiplied by the call arrival probability during that time slot.

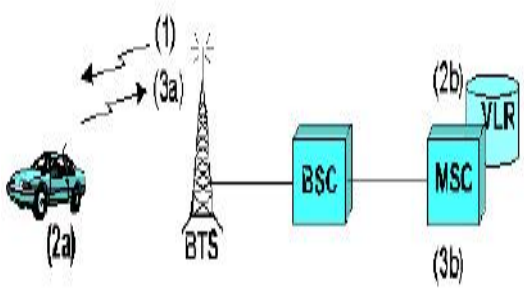

Figure 3 - Location Updating

4.2 MOVEMENT BASED LOCATION UPDATE

In the movement-based location update strategy, each mobile station keeps a count that is initialized to zero after each location update. Whenever it crosses the boundary between two cells, it increases the count by one. The boundary crossing can be detected by comparing the IDs of those two cells. When the count reaches a predefined threshold, says M, the mobile station updates its location, and resets the count to zero. The movement-based strategy guarantees that the mobile station is located in an area that is within a distance M from the last reported cell. This area is called the residing area of the mobile station. When an incoming call arrives for a mobile station, the cellular, system will page all the cells within a distance M from the last reported cell. The movement-based strategy is dynamic, and the movement's threshold M can be determined on a per-user basis, depending on his/her mobility pattern. The advantage of this strategy is its simplicity. The mobile station needs to keep a simple count of the number of cell boundaries crossed, and the boundary crossing can be checked easily. An enhanced version of the movement-based location update is selective paging strategy. In this strategy the difference is that when a subscriber moves back to the last reported cell, the movement count will be reset to zero. The effect is that the total location update and paging cost will be reduced by about 10-15% with a slightly increased paging cost.

4.3 DISTANCE BASED LOCATION UPDATE

In the distance based location update strategy, each mobile station keeps track of the distance between the current cell and the last reported cell. The distance here is defined in terms of cells. When the distance reaches a predefined threshold say D, the mobile station updates its location (i.e., cell ID). The distance-based strategy guarantees that the mobile station is located in an area that is within a distance D from the last reported cell. This area is called the residing area of the mobile station. When an incoming call arrives for a mobile station, the cellular system will page all the cells within a distance of D from the last reported cell.

In location management mechanisms, that incorporate the distance-based location update scheme with the selective paging mechanism that satisfies predefined delay requirements. In the distance-based strategy, when an incoming call arrives, the cellular system will page all the cells within a distance of D, the distance threshold, from the last reported cell of the called mobile station within one polling cycle. To compute the distance between two cells in a cellular network, an address can be assigned to a base station based on the position of the base station in the virtual hexagonal network. Therefore the distance between two cells can also be computed.

5 CONCLUSION

In this paper several static location management strategies for identification of user, updating the user location in location server based on a hierarchical tree structure database are discussed. Static location management uses one combination of search, update and search-update strategies throughout the execution. It was noticed that performing search-updates significantly reduced aggregate costs.

Dynamic location management and tracking scheme are also discussed. Location management about mobile host is replicated, so, not all MSSs need to store the location of every mobile host. Mobile hosts that are query more often than others have their location information stored at a greater number of MSSs. The set of MSSs that store a mobile host's location change dynamically as the host moves from one part of the network to another. Also, MSSs that store location information of frequently queried mobile hosts store information about fewer hosts than the MSSs that only store location information of infrequently queried mobile hosts. As a result, the location directory is fairly distributed throughout the network, and no single MSS is overburdened with the responsibility of responding to location queries. The location management scheme imposes low computation, communication and storage overheads. Moreover, mobile hosts and the wireless links do not incur any of these overheads, which is a desirable feature as they are usually resource poor. The overheads are visible to the MSSs and the fixed wire line network, which are comparatively resource rich.

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