ISSN No. 0976-5697

Volume 5, No. 2, March 2014 (Special Issue)

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Location Management in Mobile Networks

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Abstract: Mobile computing is a new emerged computing paradigm in now a days. Data management and location management in this paradigm poses many challenging problems to the Mobile database section. In the past decade, the production of Mobile communications has experienced an expensive growth due to recent technological advances in mobile networks. Location management is a very important problem among these challenges.

It consists of updating the location of the user, searching the location and retrieving search-updates. When the host changes its location, an update occurs. When the host want to communicate with a mobile host whose location is unknown to the seeking host, a search occurs. A search-update occurs after a successful search, when the seeking host updates the location information corresponding to the searched mobile host. The main aim of a good location management scheme should be to provide efficient searches and updates. In this paper, various location management schemes, various search & update procedures are discussed.

Keywords— Location, MS, MSC, BS, MSS

I. INTRODUCTION

Managing location information of mobile nodes is an important topic in mobile computing systems. Location management is one of the primary issues in cellular networks. It deals with how to trace subscribers on the move and how to update his or her movements. In mobile communication domain, they are going to hold more subscribers; the size of the cell must be reduced to make more efficient use of the limited frequency spectrum allotment. This will add to the challenge of some fundamental issues in cellular networks. Location management consisting of updating the location of the user, searching the location and accomplish search-updates. Various methods can be discussed in this paper for the efficient performance of updating, searching and search-updating procedures throughout the execution.

In a cellular network, a service coverage area is divided into smaller hexagonal areas referred to as cells. A BS serves each cell. The BS is fixed. It is able to communicate with mobile stations such as cellular telephones using its radio transceiver. The BS is connected to the mobile switching centre (MSC), which is, in turn, connected to the public switched telephone network (PSTN). The frequency spectrum allocated to wireless communication is limited, so the cellular Concept was introduced to reuse the frequency. Each cell is allotted a certain number of channels. To elude radio interference, the channels assigned to one cell must different from the channels assigned to its neighboring cells. The radio interference between them is bearable. By decreasing the size of the cells, the cellular network can increase its ability, and therefore to serve more subscribers.

A MS communicates with another station, either mobile or land, via a BS. A MS cannot communicate with another MS directly. To make a call from a MS, the MS first needs to make a request using a reverse control channel of the current cell. If the request is allowed by the MSC, a pair of voice channels will be assigned for the call. To route a call to a MS is more complicated.

The network first needs to know the MSC and the cell in which the MS is presently located. How to find out the current residing cell of MS is an issue of location management. Once the MSC the cell of the MS, it can assign a pair of voice channels in that cell for the call. If a call is in progress when the MS proceeds into an adjacent cell, the MS needs to get a new pair of voice channels in the adjacent cell from the MSC so that the call can continue. This process is called as 'handoff 'or 'Handover'. The MSC usually adopts a channel assignment procedure that prioritizes handoff calls over New calls.

Providing connection-oriented services to the MS requires that the MS be always connected to the rest of the network in such a way that its movements are Transparent to the users. This would require efficient location management in order to lessen the time taken for updates and searches, so that there is no loss of Connection. The ability of mobile hosts (MHs) to independently move from one part of the network to another part in a mobile computing system sets it apart From static networks. The network design and topology keep changing in mobile computing systems rather than In the static networks. The mobility of some nodes in the network raises interesting points in the management of Location information of these nodes.

Location server maintains the details about mobile User, it consist separate location register for each MS. Creating a fixed location register of all the nodes a priori Is not a solution. The location register has to be dynamically updates account for the mobility of the MSs. The design of a location register whose contents Change dynamically raises important points.

(a) When should the location register be updated?

(b) If the updates are done each time an

MS's location changes, the register will always have the latest location information, reducing the time and effort in Locating an MS. However, such a policy imposes burden on the communication network and the location servers, i.e., nodes that maintain the register, (b) should the location register be maintained at a centralized site, or Should it be dispensator? A central location server has Problems with regard to robustness . This leads us to the Next questions. (c) How the location information Be dispensator among the location servers? And (d) Is the location information about an MS be Copied across multiple location servers? It is not possible to a priori calculate the variations in spatial

distribution of MSs in the network and the frequency With which node location will be updated or queried.
A location management procedure is a combination of search strategy, update strategy and search-update Strategies throughout the execution.

II.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 the subscriber stays.

To keep the system updated with the current subscriber location information, the MS must inform the system Whenever it changes location region. A location region contains one or more cells in which a MS can move around without need to update the system on Its location. A location region 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 region. If the MS moves between cells belonging to different location regions, network must be informed via a method called location updating.

Suppose a cellular communication system that divides the geographical region served by it into smaller regions, Called cells. Each cell has a BS, also called as the mobile service station (MSS). The figure shows a logical view of a mobile computing system. A fixed wired network connects the MSS to each other. A MSS can be in wireless Communication with the mobile nodes in its cell. Location of a MS has may alter with time. It can move from its present cell to a neighborhood cell while participating in a communication period, or it may stop communicating with all other nodes for a period and then pop-up in another of the network.

A mobile host can communicate with other mobiles Only through the MSS of the cell in which it is located. If a node wishes to communicate with a mobile host, first It has to determine the location of MS (the cell in which the MS is currently residing). This location information is stored at location servers. Depending on the frequency of location updates, this location information may be ongoing, or out-of-date. Once the location of the MS has been calculated, Information is routed through the wired network to the MSS of the cell in which the MS is present. Hence the MSS relays the information to the destination MS over a wireless channel. We assume that MSSs act as location servers. Hence all the MSSs collectively maintain the Location registers.

III. MECHANISMS FOR LOCATIONMANAGEMENT

The Base Transceiver Station (BTS) of every cell continuously transmits the location area identification on the Control channel (BCCH). When the MS detects that the broadcast location area identification is different from the one stored in the SIM, it performs a location update. If the mobile subscriber is unknown to the MSC/VLR

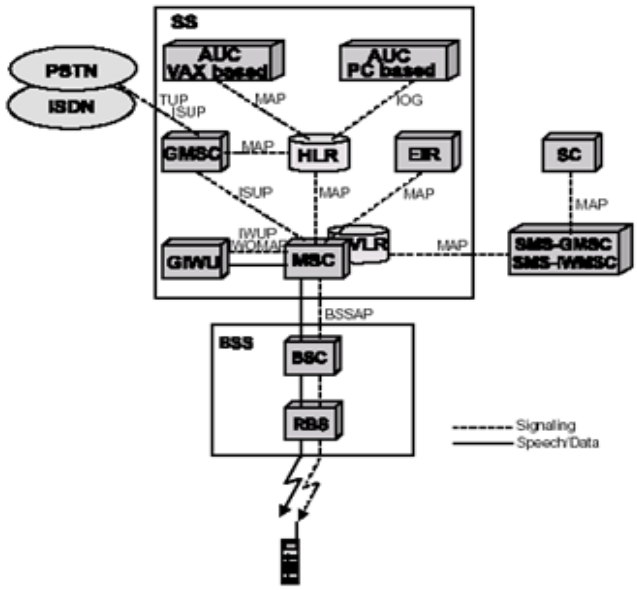

Figure. 1: Logical view of a mobile computing system

Then the new MSC/VLR must be updated with subscriber details. This subscriber details comes from the HLR.

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

a. The mobile station requests a location update to be carried out in the new MSC/VLR. The IMSI is used to identify the MS. An IMEI check is also performed.
b. In the new MSC/VLR, an analysis of the IMSI number is taken out. The result of this analysis is a modification of the IMSI to a mobile global title which is used to address the HLR.
c. The new MSC/VLR requests the subscriber information for the mobile station from the HLR.
d. The HLR stores the address of the new MSC/VLR.
e. The HLR sends the subscriber data to the new MSC/VLR.
f. 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 HLR, it sends a location updating confirmation message to the mobile station.

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

IV.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 primary operations involved in location management is analyzed. These are location update and paging. The cellular network fulfills the paging operation. When an incoming call comes for a MS, the cellular network will page the MS in all possible cells to find out the cell in which the MS is located so the incoming call can be routed to the corresponding base station. The number of all feasible cells to be paged is dependent on how the location update operation is performed. An active MS performs the location update operation.

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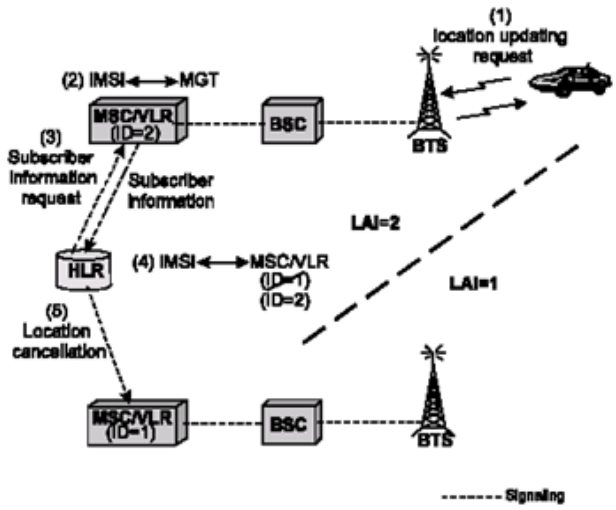

Figure. 2: Location updating

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

Location management involves signaling in both the wire line portion and the wireless portion of the cellular network. However, most of the researches only consider signaling in the wireless portion due to the fact that the radio frequency bandwidth is limited, whereas the bandwidth of the wired line network is always expandable. Location update includes reverse control channels whereas paging includes forward control channels. The total location management cost is sum of the location cost Update cost and paging cost. There is a tradeoff Between the location update cost and the paging cost.

If a MS updates its location more usually the Network Knows the location of the MS better. Then the paging cost can be lower when an incoming call Arrives for the MS. Therefore, both location update And Paging costs cannot be lowered at the same time. However, the total cost can be lowered or putting A Bound on the other cost can lower one cost.

If a queried MSS, MSSi, has the location MS_id In its directory, it is sent in the acknowledgement. If no query MSS has the location of MS_id, the Query is broadcast over network. Once MSS receives the location of the cell in which MS_id is present the messages sent through the fixed Wire network to the corresponding MSS. If MS_id has moved out of the cell since the last location update, a sequence of forwarding pointers (depending on the path taken by MS_id since it moved out of MSSi's cell) is Followed to the cell in which MS_id is currently present.

V.LOCATION QUERY

A static note, say MSS or a MS in the cel corresponding to the MSS, wishing to communicate with the target MS first needs to know the location of The target. Let the target MS's identity be MS_id. To locate the target, the function locate_MS is invoked. First, MSS searches its cache for MS_id's entry. If such an entry is found the corresponding MSS, MSSi, is probed to determine if MS_id is still in The same cell. If so, MSSi returns its own location in the Response. Otherwise, one of the virtual identities of MS_id is arbitrarily selected. This virtual identity is used by the hash function to calculate the set of MSSs that should be queried about MS_id's location which is the Read set for location information.

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VI.LOGICAL ARCHITECTURE IN MOBILE NETWORKS

Mobile system consists of MSs, mobile support Stations, and location servers. Theological network architecture (LAN) is a hierarchical structure (a tree with H levels) contains mobile support stations and Location servers. As shown in fig the mobile support station (MSS) are located at the leaf level of tree. Each MSS maintains information of the stations residing in its Cell. The other nodes in the tree structure are called location server (LS). Each location server maintains information regarding MSs residing in its sub tree. Each communication link has a weight attached to it.

The weight of a link is the cost of sending a message On the link. Let l[src][dest] represent the link between nodes are and dest, and let w(l) represent the weight of link l. the cost depends on the size of the message, Distance between the hosts, and the bandwidth of the link. For analysis purposes, we assume that, for all t, w (t0 =1.

Necessarily our cost metric is the number of messages.

VII.LOCATING MS

The problem at hand is as follows: given an MS, determine the location server (s) that will store the Location of the MS. Storing the location information of an MS at only one MSS (serving as the MH's location server) is not Required because of the following causes:

a. 1. MHs exhibit a spatial locality of reference: even though all stations in the system can potentially communicate with the network, huge volume of the References originate from only a subset of them.
b. 2. Multiple location servers for an MS make the distributed register tolerant to the failure of some of The servers.

```
Locate_MS(MS_id,MSS)
 {
```

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

When a MS moves from one cell to another, its location has to be updated at the corresponding MSSs that act as the distributed location server. The choice of the update strategy is orthogonal to the location update strategy. The parameter old_MSS denotes the MSS of the cell in which the mobile host was resident when the last update was done. The present cell's MSS is called the new_MSS. When a MSS with identity MSS_id, or an MS inside the cell corresponding to this MSS wishes to locate an MS whose identity is MS_id, the MSS takes following actions:

```
Assign_virtual_ids(MS_id)
{
int i; boolean found;
VMS_id(MS_id) {MS_id + x};
i0; found false;
while(i<x and not(found))
  if(assigned[i]=FALSE)
  {
  assigned[i]TRUE; VMS_idVMS_id(MS_id)U{i};
  Found  TRUE;
  }
  ii+1;
  }
}
```

VMS_id(MS_id)

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

VIII.LOCATION UPDATE

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

```
Location_update (MS_id, old_MSS, new MSS)
{
int i,j,vmh;
for all vmh E VMS_id(MS_id) do
  {
  ih(old_MSS,vmh);
  for all j E Si do
  send(MSSj, delete, MS_id, old_MSS);
  ih(new_MSS,vmh);
  for all j E Si do
  send (MSSj,add,MS_id, new_MSS);
  }
}
```

IX.UPDATE STRATEGIES

The simple location update mechanism is presented in fig. 3.

X.TIME BASED LOCATION UPDATE MECHANISMS

Given a time threshold T, a mobile station updates is location every T units of time. The corresponding paging mechanism is also simple. When there is an incoming call for a MS, the system will first search the cell the MS last reported, say i. if it is not present there, the system will search in cells i+j and i-j, starting with j=i and continuing until the MS is present. 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 MS dynamically determines when to update its location based on its mobility pattern and the incoming call arrival probability. Whenever a MS enters a new cell, the MS 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 MS. The weighted paging cost at a given time slot is the paging cost multiplied by the call arrival probability during that time slot.

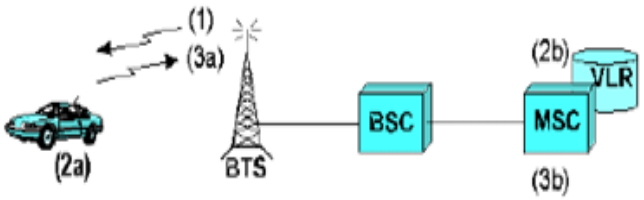

Figure. 3: Location updating

XI.MOVEMENT BASED LOACTION UPDATE STRATEGIES

In the movement-based location update mechanism, each MS keeps a count that is initialized to zero after each location update. Whenever it crosses the boundary in between two cells, it increments the count by one. The boundary crossing can be known by comparing the IDs of those two cells. When the count reaches a assumpted threshold, says M, the MS updates its location, and resets its count to zero. The movement-based mechansism guarantees that the MS is located in an area that is within a distance M from the last reported cell. This area is known as the residing area of the MS. When an incoming call arrives for a MS, the cellular, system will page all the cells within a distance M from the last reported cell. The movement-based mechanism is dynamic, and the movement's threshold M can be determined on a per-user basis, depending on the mobility pattern. The advantage of this mechanism is its simplicity. The MS needs to keep a simple count of the number of cell boundaries crossed, and the boundary crossing can be detected easily. An improved version of the movement-based location update is selective paging mechanism. In this mechanism the difference is that when a subscriber moves back to the previous reported cell, the movement count will be set 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.

XII.DISTANCE BASED LOCATION UPDATE STRATEGIES

In the distance based location update mechansim, each MS 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 assumpted threshold say D, the MS updates its location (i.e., cell ID). The distance-based mechanism guarantees that the MS is located in an area that is within a distance D from the last reported cell. This area is known as residing area of the MS. When an incoming call arrives for a MS, the cellular system will page all the cells within a distance of D from the last reported cell. The distance-based mechanism is dynamic, and the distance threshold D can be determined on a per-user basis depending on his/her mobility pattern.

In location management mechanism that incorporates the distance-based location update scheme with the selective paging mechanism that satisfies predefined delay requirements. In the distance-based mechanism, when an incoming call arrives, the cellular system will page all cells within the distance of D, the distance threshold, from 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 the 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.

XIII.CONCLUSION

In this paper several static location management mechanisms for identification of user, updates 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 mechanism throughout the execution. It was detected that performing search-updates significantly reduced aggregate costs.

Dynamic location management and tracking scheme are also discussed. Location management about MS is copied, so, not all MSSs need to store the location of every MS. MS 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 MS's location change dynamically as the MS moves from one part of the network to another. Also, MSSs that stores the location information of frequently queried MS store information about fewer hosts than the MSSs that only store location information of infrequently queried MS. As a result, the location directory is fairly distributed throughout the network, and no single MSS is overloaded with the responsibility of responding to location queries.

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