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LOCATION UPDATE STRATEGIES IN MOBILE COMPUTING

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ABSTRACT

Managing location information of mobile devices is a very much important task in mobile computing systems. There is always a trade-off occurs when the location of the device will be updated (when the device is in moving condition) and the device sending effort. Here we will follow dynamic location management strategy that has the following features: (i) all location servers need not maintain location information about every mobile device, (ii) a coterie based approach is adopted for location update and send, (iii) every device move does not result in location updates, (iv) location updates are done at a subset of location servers, (v) a subset of location servers are queried when a mobile device is to be located, (vi) the set of location servers, corresponding to a mobile device, for location update and send operations is dynamic, (vii) the dynamic nature of these sets helps alleviate situations of heavy burden on some location servers, when a large number of mobile devices are concentrated in a small geographical area. Thus, location management is done efficiently, and responsibility is shared fairly among location servers. Mobile computing is a new emerging computing paradigm of the future. Data management and location management in this paradigm are very much important in this aspect. 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**.[1] 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, I have discussed the different location management schemes, various search & update strategies.

Keywords: Mobile Station, MSC (Mobile Switching Center), Base Station, MSS (Mobile Support Station) & MH (Mobile Host) Mobile Computing, Location Management, Hashing.

1. INTRODUCTION

When we are talking about the Mobile devices in terms of mobile computing the management of location information for mobile devices is an important issue in mobile computing systems. It is one of the fundamental issues while managing the 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 and more users with one base station; the size of the cell must be reduced to make 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.

When we are talking about the cellular network, the area covered by the base station will be divided into hexagonal areas which are referred as cells. A base station covers all cells. The base station will always responsible to serve each cell. Base Station is able to communicate with mobile stations (cell phones) by using radio waves. The base station is connected to MSC (Mobile Switching Center). The MSC is connected to the Public Switched Telephone Network (PSTN). Frequency allocation in wireless communication is very much less so they always use the concept of frequency reusability. They will reduce the size of the cells so the cellular network is able to increase its capacity and can serve more subscribers.

Each mobile station always communicates with other station through the base station. Remember that mobile stations cannot communicate with other mobile stations directly. For this purpose they have to send request using reverse control channel of current cell. If the permission is granted by MSC then a pair of voice channels will be assigned for call.

The most important thing is the network must identify the MSC and the cell in which the mobile station is currently located. Now the issue will be created when the call is in progress and the user will moves from one station to another so the mobile station needs to get the

new pair of voice channels from the MSC so that the call can continue. This process is known as "HandOff" or "HandOver".

The main reason behind the connection-oriented services is because the mobile host requires the host be connected to the whole network. It requires efficient location management so that the connection loss will not occur. The ability of MHs to automatically move from one part of network to other is most important in mobile computing system. Here the location server will maintain the details about the mobile users through separate location directory for each MH. This location directory will also be updated dynamically. [2] [7] [8]

Again, when we update the location directory dynamically it creates various issues like (1) At which time we should update the directory (2) The Location directory should be maintained at a centralized site or it should be distributed ? (3) How we can distribute the location information to the servers ? and (4) Either we have to replicate the location information about MH across the multiple servers ? These four questions are most important while using Mobile Computer Location Management because we need to define a combination of search strategy, update strategy and search-update strategies throughout the whole process.

2. MOBILE COMPUTING LATEST TRENDS

In today's world mobile computing devices become small, light weight and more powerful then ever. Generally these devices use mainly two types of OS. (1) Palm OS and Pocket PC OS. Now a days these devices are capable enough for faster web browsing, managing day-to-day routines, phonebook and address management, simple word processing and also applications like spreadsheets. These devices also provides the facility like information on local restaurants, site-seeing places, maps, driving directions, weather, news etc. are also very much useful to general people.

3. SYSTEM MODEL

We assume a cellular communication system that divides the geographical region served by it into smaller regions, called cells. Each cell has a base station, also referred to as the Mobile Service Station (MSS). Figure 1 [3] shows a logical view of a mobile computing system. The mobile service stations are connected to each other by a fixed wire network. A mobile service station can be in wireless communication with the mobile hosts in its cell. The location of a mobile host can change with time. It may move from its present cell to a neighboring cell while participating in a communication session or it may stop communicating with all nodes for a period of time and then pop-up in another part of the network.

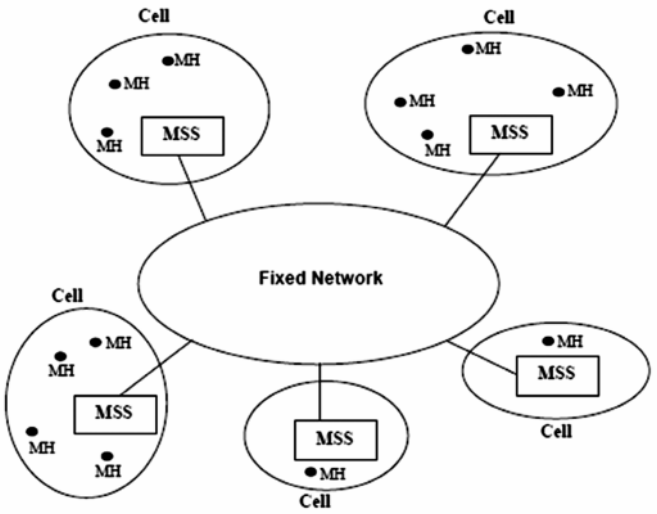

Figure 1: A Logical View of a Mobile Computing System

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 (static or mobile) wishes to communicate with a mobile host, rest it has to determine the location of the 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. Then 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.

4. MECHANISM USED FOR LOCATION MANAGEMENT IN MOBILE COMPUTING

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 SIMcard, 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 3:

1. 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.

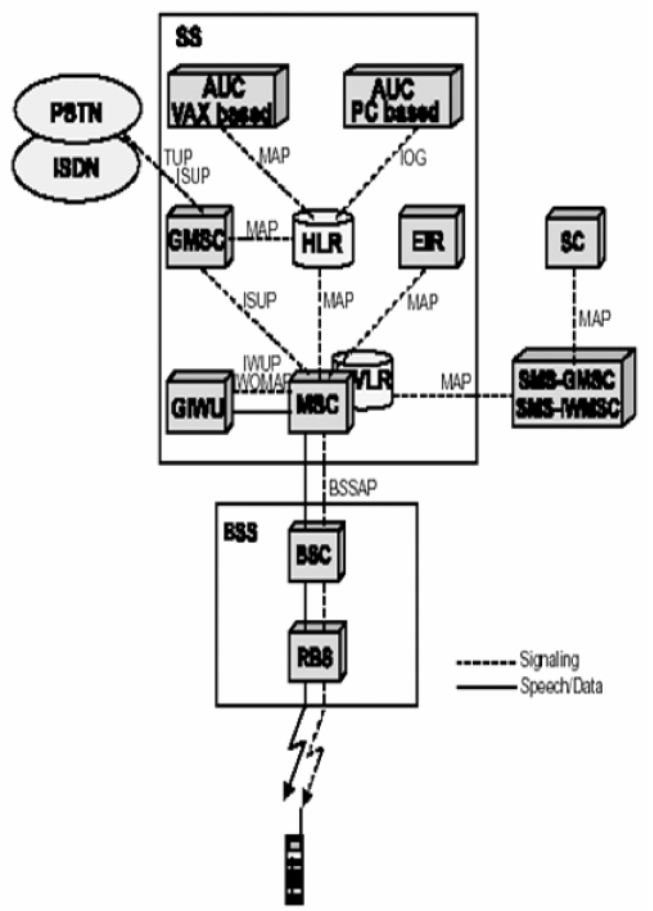

Figure 2: Another Logical View of a Mobile Computing System

2. 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.
3. The new MSC/VLR requests the subscriber information for the mobile station from the HLR.
4. The HLR stores the address of the new MSC/VLR.
5. The HLR sends the subscriber data to the new MSC/VLR.
6. 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.
7. 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.

5. LOCATING USER

Mobile computing Location Management keep track of an active mobile station within the network. Here we will discuss mainly two operations involved in location management i.e. update and paging. Paging operation will be performed when an incoming call arrives for a mobile station at that time the cellular network will page the mobile station in all possible cells and find the cell in which the mobile station is located so the incoming call can be routed to the corresponding base station. Remember that always an active mobile station will perform the location update operation.

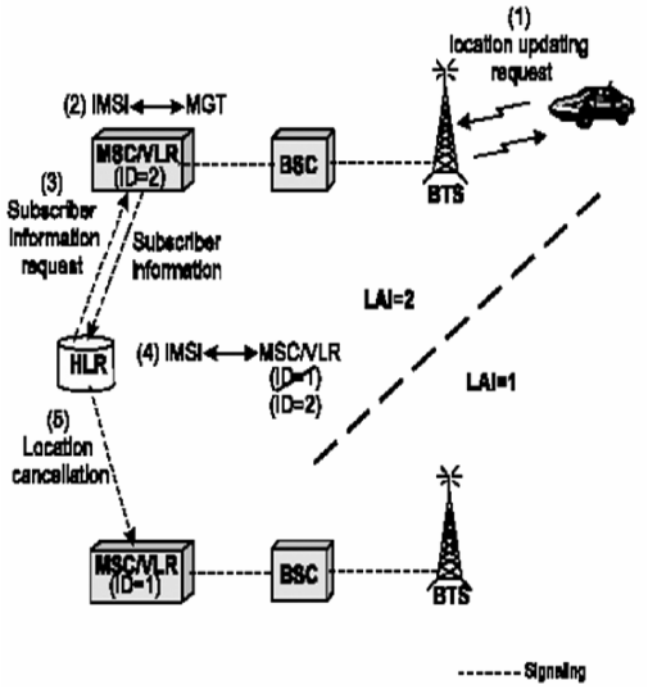

Figure 3: Location Updating

When we apply the location update scheme it can be either global or local. When we apply global then all subscribers will update their location at the same set of cells. When we apply local then an individual subscriber is allowed to decide when and where to perform the location update. This scheme is called as static if it has a predetermined set of cells at which the mobile station will generate the location update. A scheme is said to be dynamic if a mobile station in any cell depending on its mobility can generate a location update.

As we know our cellular network is divided into two portions i.e. wireless and wire line. In wire line network we have the benefit that bandwidth is always expandable which is not possible in wireless networks. Paging involves forward control channels while the location update involves reverse control channels. The total cost for location management is the sum of the location update cost and paging cost. If the mobile station updates its location more frequently then this cost will be gone up. On the other hand the location update is also necessary in all circumstances.

To find out locations for the users who are on the move and change their location more often it is a quite

challenging task. On the other hand it is also unnecessary to track the location of all users all the time.

6. LOCATION QUERY

Location is the most important thing to know when MSS or a mobile host in the cell corresponding to the MSS, wishing to communicate with the target mobile. Let us define the identity of target mobile host by MH_id. Next we define the function called locate_MH to locate the target. First of all the MSS will search its cache for MH_id entry. If the entry is found in the mobile service station, MSSi, it will check that if MH_id is still in the same cell. If yes MSSi returns its own location in the response. Otherwise its virtual identity will be selected arbitrarily. This virtual identity will be used by the hash function to determine the set of MSSs that should be queried about MH_id's location which is the reading set for the location information. If the mobile service station queried i.e. MSSi has the location MH_id in its directory, it will be send in the response. If there is no location with MH_id, then the query will be broadcasted to the whole network. Once MSS will receive the location of the cell in which MH_id is available then the message will send over the fixed wire network to the required mobile service station. If MH_id has been moved out of the cell since the last location update, a sequence of pointers which are dependent on the path taken by MH_id since it moved out of cell will be followed and locate the cell in which the required MH_id is currently present.

7. MOBILE NETWORKS LOGICAL ARCHITECTURE

When we discuss about Mobile system it will consists of mobile hosts, mobile support stations, and location servers. Our Local Area Network architecture (LAN) is a hierarchical structure (a tree with H levels) which consist of mobile support stations and location servers. In each tree the mobile support station (MSS) will be considered as leaf of the tree. Here the MSS contains the information of the host residing in the cell. Other nodes of the tree structure are called as Location Servers (LS). Here each LS will maintain the link and each link will be having weight attached to it. E.g. L1[source] [destination] will manage the link between the source and destination and let W(L1) represents the weight of the above said link. The weight represents the cost and the cost depends on the size of the message, distance between the hosts and the link bandwidth. For starting purpose we assume that t0=1.

8. HOW TO FIND THE LOCATION OF MH.

The main problem starts when we want to find the location of particular MH. In first step we have to find the location server(s) in which our MH has been stored. Here we will use a simple function which takes MH_id and MSS as argument to search for the location of MH.

```
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);
   }
}
```

Our next problem starts when the mobile host moves from one location to another, its location has to be updated at the appropriate MSSs that act as the distributed location server. Now we have the choice to decide the location update policy in terms of time, no. of movements and distance. From now onwards we denotes old_MSS for the MSS of the cell in which the mobile host was there when the last update was done. On the other hand we denote new_MSS for the current cells MSS. Following operation would be performed when location update will be done:

```
Assign_virtual_ids(MH_id)
{
   int i; boolean found;
   VMH_id(MH_id)¬ {MH_id + x};
   iß0; foundß 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;
    }
}
```

In the above function we have a set of virtual identities associated with an MH whose id is MH_id. Now when the MH moves from one location to another it will be converted from old to new.

9. LOCATION UPDATE

After finding the location of MH the old_MSS will be updated to new_MSS. This update must be done in all the LSs located on the path. E.g.

```
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);
   }
}
```

10. STRATEGIES FOR UPDATING THE LOCATION [9]

We can define various strategies for updating the location namely (1) Time Based Location Update (2) Distance Based Location Update and (3) Movement Based Location Update. Simple update process can be summarised in the following figure.

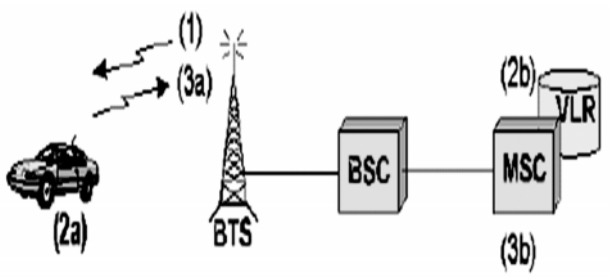

Figure 4

11. TIME BASED LOCATION UPDATE STRATEGIES

In Time Based Location Update Strategy we define a timeslot *T*, and decide that a mobile station will update the location at every *T* units of time. When there is an incoming call from mobile station, the system will search the cell in the last reported mobile station, if it is not found there, the system will search other cells until the mobile station found. In this strategy the mobile station will dynamically determines when to update its location based on its mobility pattern. Whenever the mobile station enters a new cell, the mobile station needs to find out the cells which will be paged if an call arrives and the result will be the cost for the network to page the mobile station.

12. DISTANCE BASED LOCATION UPDATE STRATEGIES

In this strategy, it is the responsibility of each mobile station to keep track of the distance between the current cell and the last reported cell. Here the distance will be measured in terms of the area covered by the particular cell. For example we consider this as *D*, here one thing is fixed that when an incoming call arrives for the mobile station, the system will page all the calls within the distance of *D* from the last reported cell. To compute the distance between two cells in a cellular network, a fix address will be assigned to a base station according to the position of the base station.

This is illustrated in below fig. [4] for a network with hexagonal cells of the same size. In such a network one can measure distance in terms of rings [5]. Consider the

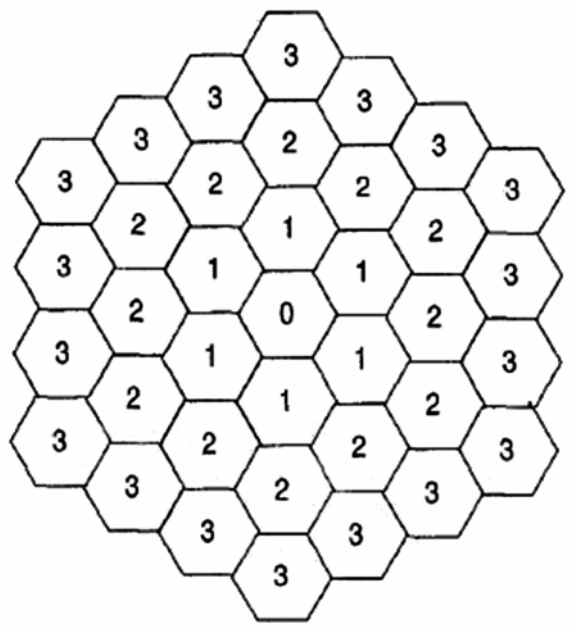

Figure 5

cell labeled "0" in Fig. The cell has six neighbors labeled "1". According to the terminology of [5], these cells form the first ring away from cell "0". The cells in the second ring are labeled "2", and so on. One can then define the distance between any two cells in terms of these rings. The distance between cell "0" and the cells in the *i*th ring is simply *i*.

A distance-based location update strategy can be defined in this topology by setting a threshold distance *d*. Suppose that the previous contact with the network took place in cell "0". For a threshold d, a location update is triggered when the distance of the mobile station from cell "0" exceeds the threshold; that is, when the mobile station enters any cell in ring *d*+l.

13. MOVEMENT-BASED LOCATION UPDATE STRATEGIES

In this strategy, each and every mobile station will create a variable called count which will become zero after each update. When the user moves between two cells, it will increase the value of variable count by one. When the value of count will reach to the specific number say *M*, then the mobile station will update its location and reset the count to zero. This strategy guarantees us that the mobile station is located in the area that is within the distance of *M* from the last reported cell. When the call has been arrived for the mobile station, the system will page all the cells within distance *M* from the last reported cell to search the location. The main advantage of this strategy is simplicity because here we have to keep record of only number of boundary crossed by the user and it is also very easy to check. Here we can also do one more thing that when user moves back to the last reported cell then we can make the count to zero so when the call arrives it has not to search for the cell.

14. CONCLUSION

In this paper I have discussed various location management strategies for identifying the location of the user as well update the location of the user. I have used three techniques i.e. (1) search, (2) update and (3) search-update. Here we can notice that out of all three methods search-update is more beneficial to perform reduction in the cost. In all of the given strategies **distance based location update strategy** is much useful and powerful among all [6] We can also apply the policy such that mobile hosts can be replicated, so it is not required for all MSSs to store the location of every mobile host. On the other hand we can also define the strategy that the mobile hosts which fire queries more often than other mobile hosts can store more MSS. In this situation the location directory will be fairly distributed throughout the network and all MSS will be equally distributed in the network. This location management scheme will create low computation, communication and storage expenses.

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