A study for Issues of the Location Management In Mobile Networks

Sami M. Halawani[1] **Dr. Ab Rahman bin Ahmad[2]** **M. Z.ubair Khan[3]**

[1,2]**Faculty of Computing and Information Technology, Rabigh Campus**
King Abdulaziz University Saudi Arabia

[3]**Department Of Computer Science and engineering Invertis University Bareilly India**

Abstract

This paper presents a hierarchical model for location management of mobile agents in global networks, Location Management in PCS systems, important issues in Location Management, Performance of Location Management, What will happen in future.
Location management is a key issue in personal communication service networks to guarantee the mobile terminals to continuously receive services when moving from one place to another. In this paper we study about the location management and its Issues in mobility networks. We also study about different system model and its components of location management. Mobility management is a necessity in highly dynamic and large-scale mobile agents' network, especially in a multi-region environment in order to control and communicate with agents after launching. Existing mechanisms for locating mobile agents are not efficient as these do not consider the effect of location updates on migration time and produce network overload. A location management protocol consists of location updates, searches and search updates. An update occurs when a mobile agent changes location. A search occurs when a mobile agent needs to be located.

Keywords: *Location Management, Personal communication services (PCSs), Visitor Location Register, mobile network.*

1. Introduction

Location management Location Management is the process to determine the current location of a mobile terminal [1]. A Mobile agent (MA) is a software process, which can move autonomously from one physical network location to another. The agent performs its job wherever and whenever it is found appropriate and is not restricted to be co-located with its client. Thus, there is an inherent sense of autonomy in the mobility and execution of the agent. Agents can be seen as automated errand boys who work for users. MA research evolved over the past years from the creation of many different monolithic mobile agent systems (MASs), often with similar characteristics and built by research groups spread all over the world, for optimization and better understanding of specific agent issues.

MOBILE computing and wireless communications are perhaps the fastest growing areas in recent years. Not only have we seen a variety of emerging wireless networking technologies (such as GSM, GPRS, WCDMA, cdma2000,IEEE 802.11 WLAN, and Bluetooth), but also are there numerous portable computing devices widely available (such as laptops, tablet PCs, PDAs, and handsets). The marriage of these two fields has made ubiquitous computing and communications possible [2]. Most MASs has the following common features:
(a) MAs are launched to complete some tasks. They may roam around the network automatically from host to host. They normally end at the launching point with their results or submit results at the last host in the itinerary.
(b) The agent management centre keeps locating these roaming agents so that it can set up

communication with them at their current locations whenever necessary. The second feature given above is actually the function of MAS mobility management. The basic operations associated with mobility management are:

1. A roaming agent updates its location frequently to the central management server (e.g. a directory server).
2. The agent management server refreshes the current location record of the agent in its location database.
3. When there is a request asking for the location of the agent, the management server searches the database and replies with the current location of the MA. Beside these three basic steps, the management server may also process issues such as out-of-date location records. Most existing MASs have provided partial mobility management, by defining different naming and locating mechanisms.

The ability of mobile hosts (MHs) to autonomously move from one part of the network to another part in a mobile computing system, sets it apart from static networks. Unlike static networks, the network configuration and topology keep changing in mobile computing systems [6]. The mobility of some nodes in the network raises interesting issues in the queried. Hence, a location management strategy should address issues (iii) and (iv) so as to ensure

1.1 Components in the location management-

i. **Base Station:-** A tower or antenna transmitting and receiving radio signals over a cell in a wireless network.

ii. **Base Station Controller (BSC):-** An agent performing functions on behalf of a group of base stations. The BSC handles the allocation of radio channels, controls handovers, performs paging and interfaces with the central network and HLR.

iii. **Cell:-**A geographical area serviced by a base station in a wireless network, also used to refer to one or more collocated base stations. Cells are the 'building blocks' of a cellular network, with overlapping cells defining the coverage area of a particular network.

iv. **Global System for Mobile Communication (GSM):-** The dominant standard for second generation mobile phone communication, defining the protocols for communication between mobile devices and network cells [12].

v. **Handoff:-** The process of transferring an in-progress call from one cell or base station to a neighboring cell without interruption.

vi. **Home Location Register (HLR):-** The central database in a cellular network, containing information on all subscribers to a particular carrier. This database also contains a record of each user's location, used to route calls to the correct cell.

vii. **Location Area (LA):-** A group of neighboring cells combined to form a larger *meta-cell*. Devices are free to move within this Location Area without performing a Location Update. Location Areas may be fixed, as in current static schemes, or allocated dynamically on a Location Update.

viii. **Location Management (LM):-** The maintenance of a record of cell locations for devices in a mobile network. The study of Location management of location information of these nodes. Creating a xed 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: (i) 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 a heavy burden on the communication network and the location servers, i:e:, nodes that maintain the directory. (ii) 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 preferable. This leads us to the next questions. (iii) How should the location information be distributed among the location servers? and (IV) 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
fair distribution of responsibility among all the location servers, and be scalable.

Management aims to reduce the net cost involved in maintaining this information.

ix. **Location Update (LU):-** Performed by a device in a wireless network to inform the network of the cell in which it resides. This Location Update is usually performed only when leaving the Location Area previously assigned to the device.

x. **Paging:-** Under a Location Area scheme, the network does not know the precise location of a device, only its general area. Paging is performed on an incoming call and involves sending a message to all cells in the Location Area to determine which one contains the destination device.

xi. **Spectrum:-** A portion of the electromagnetic spectrum containing a limited frequency range within which a mobile device may communicate. It is vital that multiple signals transmitted on the same frequency do not interfere and hence the allocation of sections of this spectrum is governed by regulatory bodies. A communications provider must purchase a license for a particular frequency band within this spectrum to Broadcast cellular data.

xii. **Subscriber Identity Module (SIM):-** A small *smart card* used in mobile phones operating under the GSM standard. This SIM card contains user identification information, as well providing storage space for phone numbers and associated data.

xiii. Third Generation (3G):- A new wireless communication specification replacing second generation technologies such as GSM. Third generation cellular networks provide for high-speed data access in addition to audio communication, with goals of high-quality multimedia and advanced global roaming[15].

2. 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 shows a logical view of a mobile computing system. The mobile service stations are connected to each other by a xed 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. 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, rst 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 xed wire network to the MSS of the cell in which the MH is present[4][5].

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.

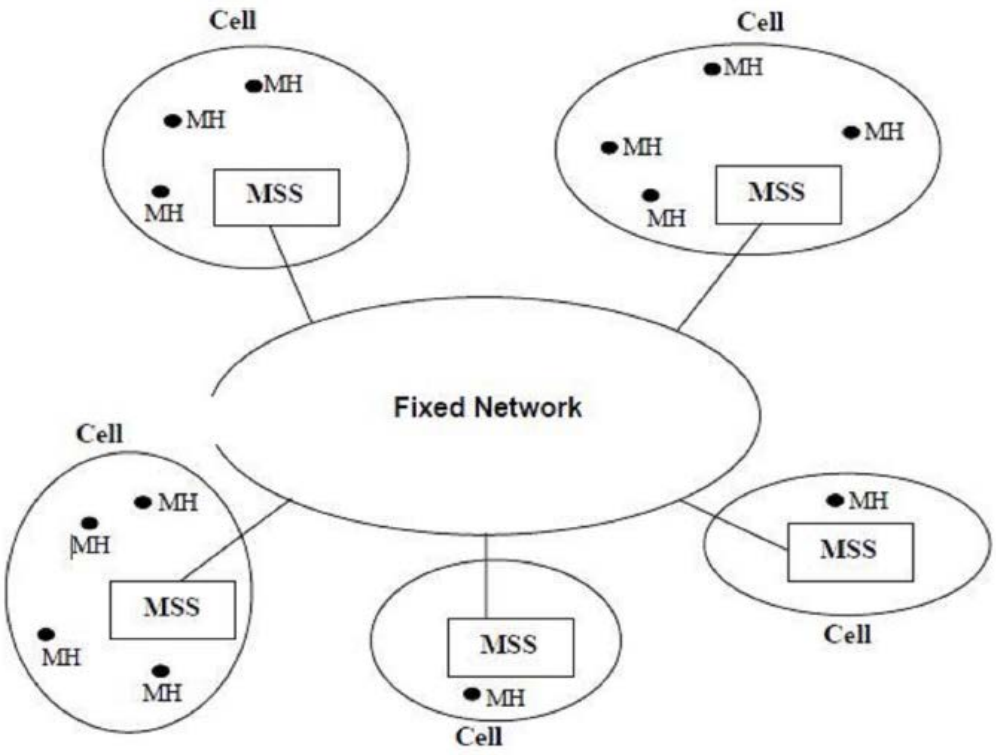

Fig.1 Logical view of mobile computer syste

2.1 Mechanism for location management

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 Figure2.

i. 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.

ii. 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.

iii. The new MSC/VLR requests the subscriber information for the mobile station from the HLR.

iv. The HLR stores the address of the new MSC/VLR.

v. The HLR sends the subscriber data to the new MSC/VLR.

vi. 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.

vii. When the new MSC/VLR receives the information from the HLR, it sends a location updating confirmation message to the mobile station.

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

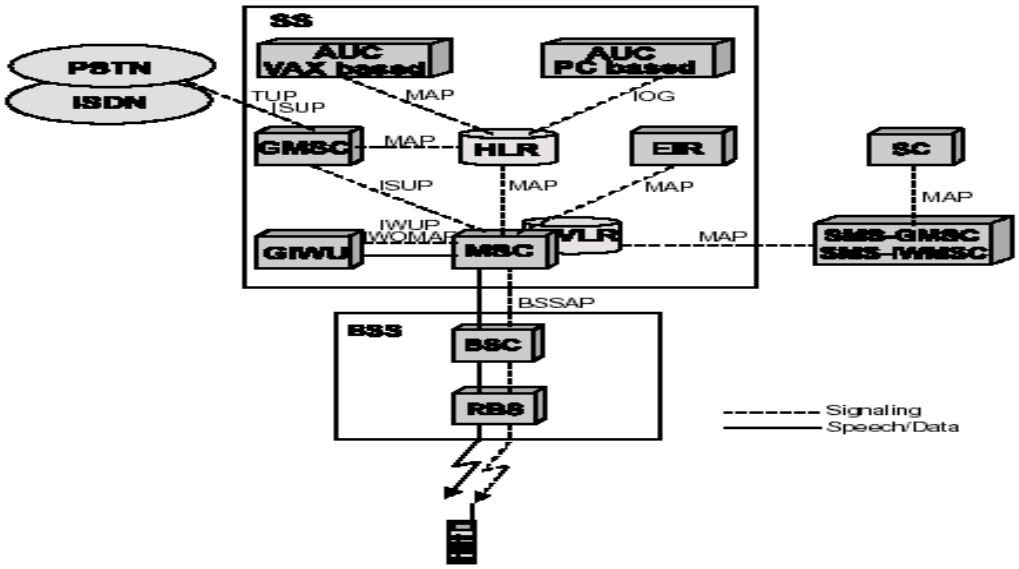

Fig 2- Architechure view of a mobile computing system

2.2 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. The number of all possible cells to be paged is dependent on how the location update operation is performed. An active mobile station performs the location update operation.

A location update scheme can be classified as either global or local, and given in figure 3. 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. Location management involves signaling in both the wire line portion and the wireless portion of the cellular network [8]. However, most researches only consider signaling in the wireless portion due to the fact that the radio frequency bandwidth is limited, whereas the bandwidth of the wire line network is always expandable. Location update involves reverse control channels whereas paging involves forward control channels. The total location management cost is the sum of the location update cost and paging cost. There is a tradeoff between the location update cost and the paging cost. If a mobile station updates its location more frequently the network knows the location of the mobile station better. Then the paging cost will be lower when an incoming call arrives for the mobile station. Therefore, both location update and paging costs cannot be minimized at he same time. However, the total cost can be minimized or putting a bound on the other cost can minimize one cost. Locating users who are on the move and often to locations, which are remote from home, is a challenging task [11]. 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.

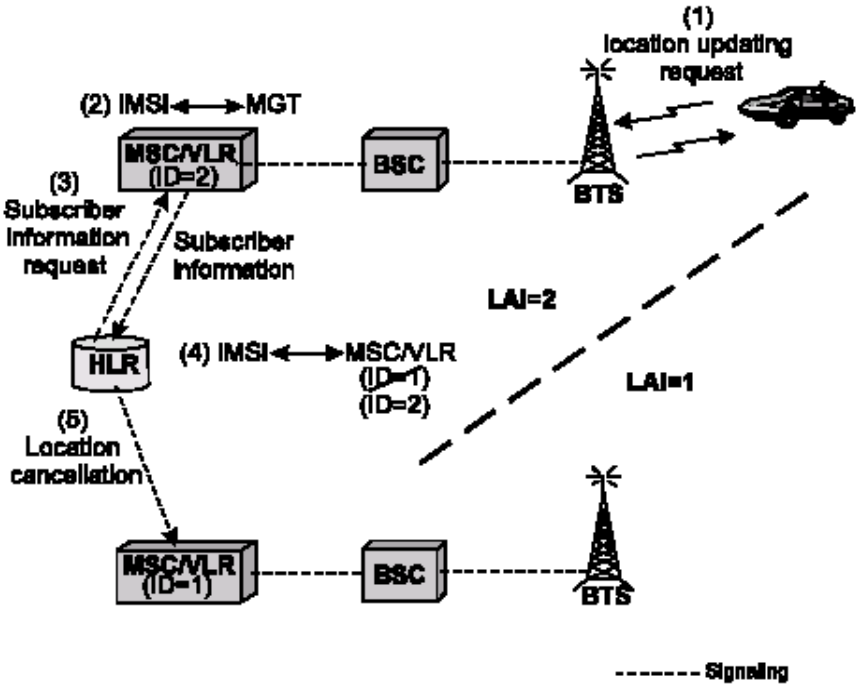

Figure 3- Location updating

2.2.1 Location management in PCS:-

Personal communication services (PCSs) include many wireless access and mobile communication services. Its goal is to provide communications for users at any time and any place [2] [3][10] as given in figure 4. The network architecture of a PCS network is shown in Fig. 1. It consists of several components which we briefly describe them as follows:

i. Mobile stations (MSs) are devices used to send and receive calls.

ii. Base stations (BSs) use radio protocol to communicate with mobile stations and wired protocol to connect with the mobile switching center (MSC). The range of a base station is called a cell. Several BSs are connected to anMSC. The coverage area of those BSs is called a Registration Area (RA).

iii. The MSC supports switching function for wireless communications and serves as an interface between MSs and the public switched telephone network (PSTN). The functions of mobile switching center (MSC) include location registration, call delivery, paging, handoff, etc.

iv. The home location register (HLR) is a centralized database containing user profiles. The user profiles record information such as the types of services subscribed, the quality of service (QoS) requirements, the billing information, and the current locations of the MSs.

v. The visitor location registers (VLRs) are dynamic and distributed databases. A PCS network usually implements hierarchical database with one HLR and several VLRs below the HLR. The VLR stores the information of MSs that are currently in its RA. The user profiles of an MS may be replicated from HLR to its current serving VLR. In general, one or more MSCs can share one VLR.We consider only one MSC is served by each VLR in this paper and the VLR and the MSC are located in the same place . This kind of implementation is more widely adopted in today's PCS systems [7].

vi. The public switched telephone network (PSTN) represents a wired backbone network. Wireless networks are not like wired networks in which every node has a fixed address and location that can be used to find the node. Hence in PCSs,

we cannot use the node's identification number to find its current location. Thus, an efficient location management scheme is required. In PCS systems today, the popular standards are GSM and IS-41. IS-41 is generally used in North America and GSM is common in Europe. The two standards both use hierarchical databases.

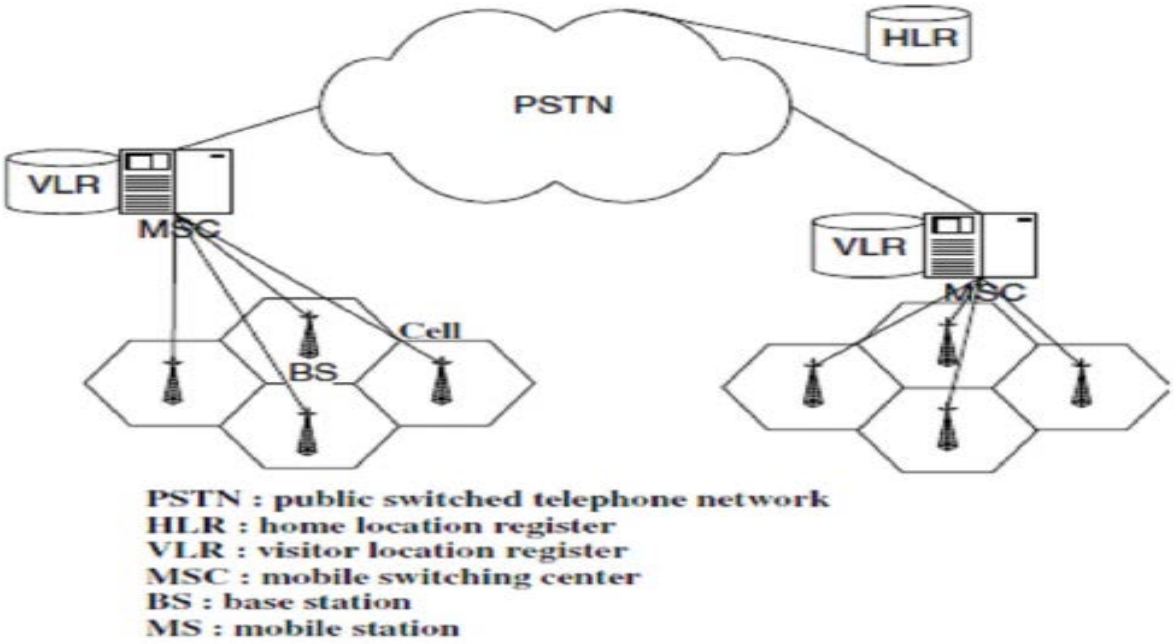

Fig. 4 PCS Network Architecture

3. Issues in Location Management:-

The study shows that Location management has three issues:

3.1 Location registration. When an MS moves to a new MSC, messages are exchanged among the HLR and the new and the old VLRs. Exchanging messages are for recording and updating the new location information of the MS in databases. The process is called location registration. There are several location registration schemes. (A) Geography: A user updates the system only when it moves to a new RA from an old RA. (B) Timer: The user updates the location only periodically with a timer. (C) Stimulus: The user performs the location update only when there is a request. (D) ON/OFF: A location update occurs only between the time that the MS is powered on and the time that the MS is powered down. In this paper, we will emphasize on geography based location registration, which is used in most of second-generation cellular systems.

3.2 Call delivery. The purpose is to find the called MS (callee) from the calling MS (caller) when the caller makes a call. Messages are exchanged among VLRs of the caller and callee and the HLR of the callee. In PCS systems, when the callee is an MS, the caller must query the callee's HLR via its VLR to know the VLR location of the callee. Then it queries the VLR of the callee to learn the current location of the callee. The MSC of the callee may assign a temporary location directory number (TLDN) for the caller and sends the TLDN back to the HLR [8]. The TLDN is forwarded to the MSC of the caller. If the location query is successful, the MSC of the caller establishes a connection to the MSC of the callee.

3.3 Paging. When an MSC receives a call for an MS, the MSC knows whether the MSis in its RA. However, it does not know which cell the MS is in. The MSC will send a paging message to all BSs belonged to the MSC. If the MS is within the cell of a BS, the BS will send an

acknowledgement back to the MSC. The paging is usually not included in counting the costs of a location strategy because every call delivery needs the paging and we can assume the paging costs are the same for all schemes. Hence, paging costs will also not be counted in this paper.

TABLE I
LOCATION MANAGEMENT ISSUES IN DIFFERENT MOBILE NETWORKS.

	identity	location	tracking strategies
GSM/ cdma2000	MSISDN	location area (LA)/ enhanced Cell ID/ <latitude, longitude>	time/movement/distance-based, BS-initiated, centralized servers (HLR/VLR), A-GPS/TDOA/E-OTD centralized servers
IP networks	IP address	subnet	time-and-movement-based, terminal-initiated, centralized servers (home agent)
ad hoc/sensor networks	IP/MAC address	2D/3D coordinates	time/distance-based, host-initiated, distributed servers (virtual home zone, grid, etc.)

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 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. Various strategies can be discussed in this paper for the efficient performance of updating, searching and search-updating strategies throughout the execution.

In a cellular network, a service coverage area is divided into smaller hexagonal areas referred to as cells. A base station serves each cell. The base station is fixed. It is able to communicate with mobile stations such as cellular telephones using its radio transceiver. The base station 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 very limited, so the cellular concept was introduced to reuse the frequency. Each cell is assigned a certain number of channels. To avoid radio interference, the channels assigned to one cell must different from the channels assigned to its neighboring cells. The radio interference between them is tolerable. By reducing the size of the cells, the cellular network is able to increase its capacity, and therefore to serve more subscribers. A mobile station communicates with another station, either mobile or land, via a base station. A mobile station cannot communicate with another mobile station directly. To make a call from a mobile station, the mobile station first needs to make a request using a reverse control channel of the current cell. If the request is granted by the MSC, a pair of voice channels will be assigned for the call. To route a call to a mobile station is more complicated. The network first needs to know the MSC and the cell in which the mobile station is currently located. How to find out the current residing cell of mobile station is an issue of location management. Once the MSC the cell of the mobile station, it can assign a pair of voice channels in that cell for the call. If a call is in progress when the mobile station moves into a neighboring cell, the mobile station needs to get a new pair of voice channels in the neighboring 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 strategy that prioritizes handoff calls over new calls. Providing connection-oriented services to the mobile host requires that the host be always connected to the rest of the network in such a manner that its movements are transparent to the users. This would require efficient location management in order to minimize the time taken for updates and searches, so that there is no loss of connection. The ability of mobile hosts (MHs) to autonomously move from one part of the network to another part in a mobile computing system sets it apart from static networks. Unlike static networks, the network configuration and topology keep changing in mobile computing systems. The mobility of some nodes in the network raises interesting issues in the

management of location information of these nodes.

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.

Another Issue in the location management is Data management as given in figure 5. It is necessary to manage users' location information as efficient as possible, since users move around the network and their current locations should be updated in the databases. Especially when there are many users in a network, the mobile system suffers from the scalability problem. By *scalability*, we mean "the ability of a network to adjust or maintain its performance as the size of the network increases (and the demands made upon it increases), yet the performance of a network tends to degrade as the number of mobile users increases".

To resolve the scalability problem in a mobile computing system, Pitoura et al. proposed a hierarchical system with a tree topology[6]. This system relieves the scalability problem by updating the databases in the system locally. In a hierarchical database system, clustering the

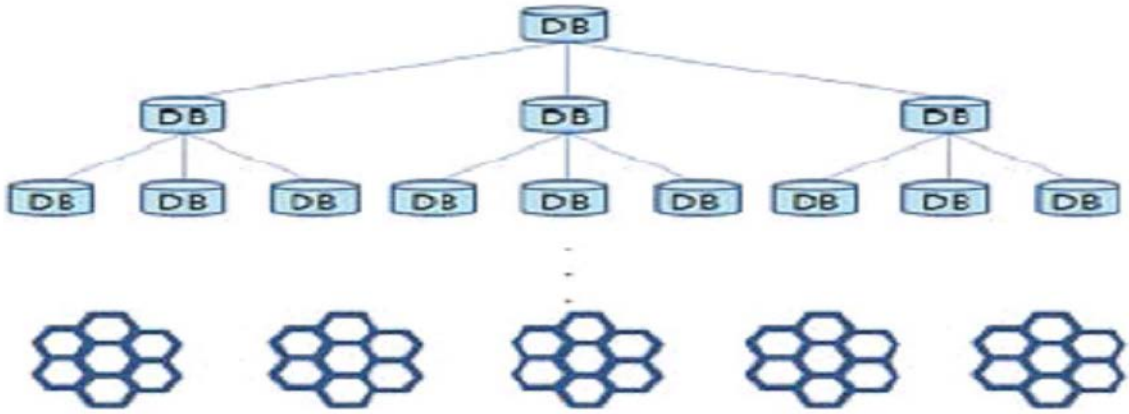

Fig. 5 A hierarchical location database system

Databases are a very important issue to reduce the update cost. But the optimal clustering can only be obtained exhaustively because the user moving patterns are dynamic in their nature.

Jixiong et al. developed a location database clustering algorithm and later called it *the set-cover algorithm*. Their algorithm utilizes the "greedy" approximation set-cover algorithm for clustering with a bottom-up approach. However, once some of the databases in cells are grouped into a cluster at the bottommost level, it is difficult that the movement information among the cells is used properly for clustering in the upper levels toward the root. In this paper, we propose a top-down clustering algorithm for the location databases [9]. In our clustering algorithm, we consider the number of visits to each cell by users, called *the visit count* of a cell, as well as that is, our algorithm takes into account both the node (cell) and edge information, while the set-cover algorithm utilizes only the edge information for clustering [13].

4. Future Work

The location management scheme proposed here is a significant departure from current research and signals a wide range of future work. Much of this is scheduled for completion in the near future with continual developments to progress for a significant period of time. It is expected that this research will form the basis of a series of publications, ideally signaling a new direction for research into location management techniques, in 3rd generation mobile networks that is DYNAMIC-3G and STATIC- 3G location management schemes for 3G wireless cellular systems (particularly UMTS), Distributed computing and object oriented [15].

5. Conclusion.

In this paper several static location management strategies for identification of user, update 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. This paper also discussed about the location in PCS (Personal Communication System) and Issues in location management. Also covering the database issues in location management. After discussing issues of location management, the performance of location management and future work also discussed.

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