An Efficient Approach for

Dynamic Location Management in

Wireless Networks

A dissertation submitted in the partial fulfillment for the award of Degree

of

Master of Technology

In

Software Technology

by

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2015

DECLARATION

I hereby want to declare that the thesis entitled **"An Efficient Approach for Dynamic Location Management in Wireless Networks",** which being is submitted to the **Delhi Technological University**, in partial fulfillment of the requirements for the award of degree in **Master of Technology in Software Technology** is an authentic work carried out by me. The material contained in this thesis has not been submitted to any institution or university for the award of any degree.

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This is to certify that the thesis entitled **“An Efficient Approach for Dynamic Location Management in Wireless Networks”** done by **MANU SRIVASTAVA** (Roll Number: **2K12/SWT/08**) for the partial fulfillment of the requirements for the award of degree of **Master of Technology** in **Software Technology** in the **Department of Computer Science & Engineering**, Delhi Technological University, New Delhi is an authentic work carried out by him under my guidance.

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ABSTRACT

Every aspect of the life has been touched by the recent advances in cellular mobile. In mobile computing, terminals (MTs) move indiscriminately from one place to another within a geographical area which is often well-defined. A challenging task is to track the location of the mobile effectively to provide timely services to mobile users, so that the connection establishment delay is low. Conventionally, the network uses paging to determine the exact location of the mobile and this takes anywhere between 500ms to several seconds. The cost factors for location update and paging are often mutually contradictory.

Numerous location update reduces location uncertainty about the mobile terminal, which in fact saves the expenses of paging delays and paging channel resources. However, it imposes a elevated power utilization in the mobile terminal and requires provisions of more control channel resources. On the other hand, less frequent location update reduces power consumption in a mobile terminal and requires less control channel resources; it nevertheless increases location uncertainty, which requires either larger paging delays or more paging channel resources for locating a called mobile terminal. This is a basic trade off in tracking mobile users .

In this thesis, we productively establish a new logical model accessible for the study of the significant dynamic movement-based location management mechanism for wireless networks with HLR-VLR architectures with intelligent paging, to determine the total cost which is comprised of location update cost and paging cost. Analytical results show that proposed incorporated new scheme, it does decrease the whole cost for location management compared to the earlier scheme, and obtain the improved performance and thus reducing the call setup time.

Keywords : HLR, VLR, LA, LU, MSC, BS, CMR

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CHAPTER - 1

Introduction

1.1 Background

Key technical aspect in the mobile communication systems is the mobility management. The main purpose of mobility management is to enable mobile terminals so that the users can communicate with each other constantly during the movements and the data loss must be minimized to the satisfying the needs of challenging low-latency, isochronous, real-time applications. The mobility management problems comprise handoff, location management, paging, authentication, authorization, accounting and the security.

Location management is a significant procedure that facilitates the network to uphold the latest location information. Most of the wireless systems preserve location information using the location update and paging mechanisms. Location update is a process in which mobile terminal informs its up-to-date location information willingly. Paging is one more process for a network to track the mobile terminal's current location. Though, more paging by system involves less location update by mobile terminals, and vice visa. Many researches paying attention on the equilibrium among the two in order to keep limited wireless resources. A network can group cells or base stations into Routing Areas (within a packet switch domain) or Location Areas (within a circuit switch domain). When the mobile terminal stays at the same routing area or location area, it is not essential to relocate the signaling to each other between the device and the system. In the other words, there is no location update by the terminal and paging by the system for the duration of this period of time. Based on this notion, many location update and paging approaches are developed. Many location update approaches have been projected, together with time-based, distance-based, and profile-based approaches. On the other hand several paging schemes have been proposed, including Shortest-Distance-First, Sequential Paging and Blanket paging,.

Mobile communication systems enable the mobile terminals to cost-effectively transport any form of information between any required locations at any instance. Location management is a key component in the process of wireless personal communication networks. In a wireless communication networks, a given geographically serviced area is separated into cells. There is a base station in every cell, which is used to converse with mobile users over pre-selected radio frequencies. Several cells are grouped collectively and are linked to a mobile switching centre through which the calls are then routed to the telephone networks. Mobile switching centre is a telephone exchange specially designed for mobile applications. It is the crossing point between the mobile phones via base stations and the public switched telephone network, which makes the mobile services largely accessible to the community.

In GSM system (Global System for Mobile communication), the mobile Application Part, which is the 2G cellular networks, the location management system resides in MSCs. It contains two databases to make possible the tracking of mobile terminals: the home location register (HLR) and the visitor location register (VLR). HLR includes the permanent data of the mobile terminals whose primary subscription is within the area. For each mobile terminal, it holds a pointer to the VLR to aid the routing incoming calls.

The visitor location register contains an interim or to say temporary record for all mobile terminals currently on the go within the service area of the MSC. The VLR pick up the information for handling calls to or from a visiting mobile terminal. A wireless network is separated into many location areas to make possible the tracking of a moving mobile terminal. Each location area includes tens or hundreds of cells and is serviced by a VLR i.e. visitor location register.

1.2 Mobility Management

Since the geographic locations of the subscriber are known in advance in a wired network, the incoming calls are routed according to a static routing scheme to suitable switching centers. A switching center then enlarge a local loop, either fixed wire or fixed radio, in order to deliver the incoming call to the subscriber's geographical location. In a cellular mobile network, the mobile terminals are free to travel in the exposure area of the network. Therefore, the mobile terminal may cross many cells before the completion of a call. As a result, association between the mobile terminal and the base station assumes time-variant characteristics. The recognition of the mobile terminal usually does not provide explicitly its location information. In a mobile radio communications network, whenever there is a requirement to set up a communication channel with a particular mobile terminal, the network first has to find out which one of Base Stations can communicate with called mobile. In order to deliver effectively the incoming calls to a Mobile Terminal, a mechanism is required to track its current residing cell. In GSM, the service area of a network is partitioned into a number of smaller areas called Location Areas (LA). Each location area consists of a number of contiguous cells, and is the basic unit area for registering location of the mobile. The traffic generated in a location area for tracking the mobile terminal is referred to as Paging Traffic. The mobile terminal performs a Location Update through signaling network when it goes through a new location area. The call delivery to the mobile terminal is attained by a paging procedure. When the paging signal is received, the mobile sends a reply that allows the associated Mobile Switching Center (MSC) to determine its current residing cell.

Depending on the distance between current and home location area of the mobile terminal, the location update signaling messages may have to go through quite a few transitional Signaling Transfer Points before reaching their destinations. Therefore the location update may generate a significant traffic load on the network. Due to increasing density of cellular mobile users, the delay for completing a LU may also increase proportionally if efficient tools are not developed to minimize this load on the network. The problem of minimizing this location update cost on the network with the paging traffic capacity as a constraint on the size of location area is considered in the proposed work. This problem has fascinated a noteworthy consideration of the researchers

There are two fundamental procedure in location management, firstly the location update mechanism and secondly the paging scheme. Location update is the method through which system tracks the location of mobile terminals that are not in conversations i.e. active mode. The mobile terminal reports its up-to-date latest location information vigorously. The paging area may comprise of one or more cells. The system searches for the mobile terminal, when the incoming call arrives, by transfer polling signals to each cells in the paging area. This process of searching is referred to as paging. To perform location update and paging incurs a significant amount of cost and which should be minimized in the systems e.g., the base stations, wireless bandwidth and processing power at the mobile terminals and databases.

The value of mobility tracking depends on the expenses of the subsequent resources:

1. The network uses wireless resources (downlink bandwidth) for paging users.
2. The mobile terminal uses power for listening to beacons broadcast by the radio ports (to detect changes in its own location) and for alerting the network of a location change.

The latter usually has higher power needs in addition has the obligation for uplink bandwidth. If the customer or the user is less mobile and gets frequent calls of short duration, paging all cells in the registration area for each call is probable to be uneconomical and wasting the expensive wireless resources. Such a situation may arise with the introduction of wireless computing, in which case the user's calls may really be bursts of data. On the other hand, maintenance of the closer track of the user's location involves additional expenditures, since the mobile terminal have to listen more regularly to detect slighter changes in location, and must alert the network subsequently. Mobility tracking also imposes a noteworthy load in terms of signalling within the wire line network and changing user location approach to optimize power and bandwidth influences the design of the wireless signalling system as well.

Till now, more and more mature technologies are growing, and each system has its own exclusive uniqueness that cannot be replaced. An interoperable model is expected to bring more services for every mobile terminal. In order to decrease redundant signaling transfer and to detect the best location area update event, we projected to address this problem by taking into consideration two parameters: the location area update mechanism and the Paging scheme.

A trade off therefore has to exists among the cost of location update and the cost of the paging of mobile terminals. Given the respective cost for location update and terminal paging, a good mobile terminal tracking strategy should opt for the location update time points such that the total cost (location update and terminal paging) is minimized. Moreover, the scheme must be sufficiently uncomplicated and computational constraints are minimal. It is infeasible to implement a computational intensive policy in a mobile terminal which has a very limited energy supply and minimal computational power.

1.3 Architecture

As shown in Fig. 1, the service area in wireless cellular networks is segregated into location areas, and each location area contains a number of cells. The mobile terminals are able to roam freely within the location area with no update of its location information and would only require doing the location update when it enters a new location area. When an incoming call turns up, the network locates the mobile terminal by paging all cells within the location area. A cell, usually symbolized with a hexagon, is served by a base station that transmits paging messages to all mobile terminals within the cell over a common broadcast channel. All base stations of the location area are directly connected to the mobile switching center via the backbone network. MSCs are the telephone exchanges and they act as interfaces between the MT and the PSTN. Moreover, the location management system resides in the MSCs. The BS-MT links are wireless and the MSC-BS links are generally fixed and wired.

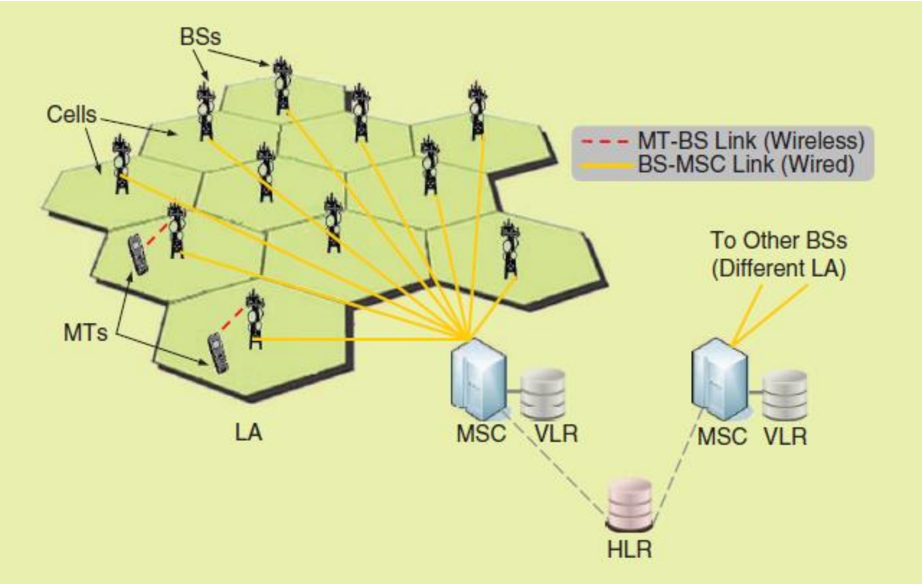

Fig 1: The Location management architecture of 2G cellular mobile networks [5]

1.4 Location update schemes

There are two basic operations in location management: *paging and location update*. The system tracks the position of mobile terminals that are not in talk by the location update is the process. The mobile terminal reports its recent location information dynamically. A paging area (PA) may include one or more cells. The system search for the mobile terminal by transfer polling signals to cells in the paging area, when the incoming call arrives. This searching process is referred to as paging. To perform location update or paging incurs a significant amount of cost and which should be minimized in the systems (e.g., wireless bandwidth and processing power at the mobile terminals, the base stations, and databases).

Location update are broadly are of two types i.e. static location update and dynamic location update. In dynamic schemes, the size of a location area is determined dynamically according to the changes of mobility and calling patterns of mobile terminals. Three kinds of dynamic location management schemes have been proposed [4], which are, distance based, movement based and time based.

To realize the dynamic location update scheme in the real world wireless communications network, we have to consider the real network architectures with HLR-VLR databases. The location management have a brave task to design a high-quality plan that can decrease the cost of the location update and paging together. In this paper, we test the obstruction of the performance investigation of the dynamic movement-based location management process for wireless networks with the HLR-VLR architectures.

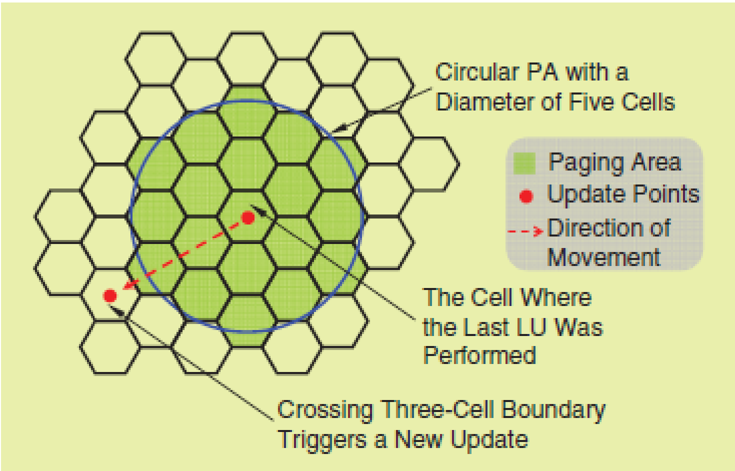

Fig 2 : The PA for movement-based LU with *d* =3 [5]

1.5 Paging

In the mobile telephony systems, the frequent use of broadcast information is to set up channels for one to one communication among the mobile terminals and the base station. This is known as the paging. The three different paging procedures i.e.

sequential, parallel and selective paging. The details of the process of paging fluctuate somewhat from network to network, but on the whole we know a partial number of cells where the phone is located and generally this group of cells is called a Location Area in the GSM system and if a data packet session is involved then it is known as Routing Area.

Paging is the process in which the network alerts an idle mobile terminal about an incoming call. The network broadcasts paging announcement into each cell of the terminal's last reported paging group. Upon this message appeal, the mobile terminal becomes active and logs on to the network. Different cells may consume different radio resources to page a mobile device. Consequently the resources consumed for paging are different between different cells. An efficient paging algorithm must take into account this non-uniform distribution of paging costs. Moreover the network topology, the mobility patterns, and the call patterns also changes dynamically and continuously. The efficient paging algorithm must be aware of the dynamic behaviours so that the competence is always held.

Several schemes have been proposed for reducing the signalling load generated in a cellular wireless network system for paging. The simplest one is called blanket paging, wherein all the cells in a location area under the coverage of a mobile switching centre are polled at the same time in one polling cycle. Though the latency involved is minimum, a major drawback of this scheme is an undesirable increase in cost as the number of cells within the location area is generally large and bandwidth utilization is reduced.

Paging is performed on the onset of an incoming call and which involves sending a query message on the downlink signalling channel to all cells in the location area. All the mobile terminals monitor the common control channel periodically to check whether it has been paged or not. When the mobile terminal observes a paging signal for itself, it responds by transferring an acknowledgement communication over the uplink signalling channel. In the basic form, the total area to be paged, equals the location area and depends on the accurateness and regularity of location update. A simple trade-off exists here - the better the location prediction through location update procedure, the lesser is the size of paging area. A smaller paging area results in a compact paging cost as the paging cost is comparative to the number of paged cells. To reduce the paging cost further, as an alternative of paging all the cells within the location area at one go, the location can be partitioned into several paging areas that will be polled sequentially.

1.5.1 Intelligent paging:

The scheme of selective paging can be carried forward with efficient intelligent paging strategies. By intelligent paging, we refer to a set of schemes like rule based, bio-inspired, etc., where the sequential paging scheme is more modified by computing the paging order of the diverse paging area based on pre-established probability metrics. The primary goal is to poll the correct paging area in the first pass with a high degree of accomplishment. Overall, intelligent strategies involve even more computational overhead.

1.6 Call to Mobility Ratio (CMR)

Every wireless network system supports its service range at a specific speed. Hence, movement speed is the significant apprehension in designing dynamic location management and paging schemes. A appropriate strategy will eradicate redundant signaling transfer, and will select a superior location update. Among various location update strategies, the time-based and distance-based approach are the two most commonly used approaches in offered wireless networks. Taking into account the time-based strategy, the terminal carries out location update periodically at a predefined constant interval. The system measures the distance between the current cell and the last location update cell, then calculates the speed of the mobile terminal. In the distance-based location update, the system sets a timer and thus calculates the speed. In addition to speed, this system will also get the mobile terminal pathway of advancing

Under most movement behaviors, speed is associated to the turn-angle. When driving at a high speed, it is hard to supervise the vehicle when making a turn due to the tendency of inertia to be unbalanced. Hence, all roads must have a regulated speed limit for all type vehicles. On the other hand, the movement behavior of a mobile user in low speed is analogous to a random walk. Based on this law of nature, paging scheme is planned. When the mobile terminal is at a low speed, the paging area is the largest. The random walk direction of advancing is difficult to predict. However, the mobile terminal which is at a higher speed, the direction is easier to predict comparable. As a result, the paging area will be smaller. Even paging scheme will reduce the paging cost in some case, but it is not efficient at low mobility.

Hence, the important characteristic in the present topic is the call to mobility ratio (CMR). Call to mobility ratio (CMR) is calculated by dividing the average number of incoming calls by the average number of cell crossings the user makes in a given time interval. Users with lesser CMR values require more frequent location updates than users having higher CMR.

The new scheme could reduce the total location update cost drastically for high CMR, and thereby decrease the total cost. The rest of this paper is organized as follows. In chapter 2, we discuss the related work. In chapter 3, we discuss location update and paging strategy. Performance comparison is tackled in chapter 4. Finally, we present the wrapping up in chapter 5.

CHAPTER - 2

Related work

2.1 Problem associated with mobility management

In second generation systems, a mobile terminal reports its location whenever it enters a new location area. Since the location area consists of a number of cells, the exact location of the mobile terminals should be determined for a call delivery. This is done by paging the cells in the last registered location area. When the location area is comprised of a group of cells that are permanently assigned to that location area, and is fixed for all mobile terminals, the location management scheme is called static. There are a number of inefficiencies associated with the static location update and paging schemes.

1) Unwarranted location updates may be performed by mobile terminals that are located around location area boundaries and are making frequent travels back and forth between two LA.
2) Need the network to poll all cells within the LA every time a call arrives may result in unnecessary volume of wireless broadcast traffic.
3) The mobility and call arrival pattern of the terminals vary, and it is generally complicated to select a location area size that is optimal for all users. An ideal location update and paging mechanism should be able to adjust on a per user basis.

Dynamic location update schemes are projected to deal with the problems of the static schemes. In the dynamic schemes, the location area size is determined dynamically according the changes of mobility and calling patterns of mobile users.

2.1 Types of location update schemes

Basically there are three types of dynamic location update schemes: distance-based, movement-based and time-based.

1) Distance-based location update:

   Location update is performed whenever number of cells (the distance) between the current cell of the terminal and the last cell in which the update is performed is d, where d is the distance threshold.

2) Movement-based location update:

   Location update is performed whenever the mobile terminal completes d movements between cells, where d is the movement threshold.

3) Time-based location update scheme:

   The location update is performed every t units of time, where t is the time threshold.

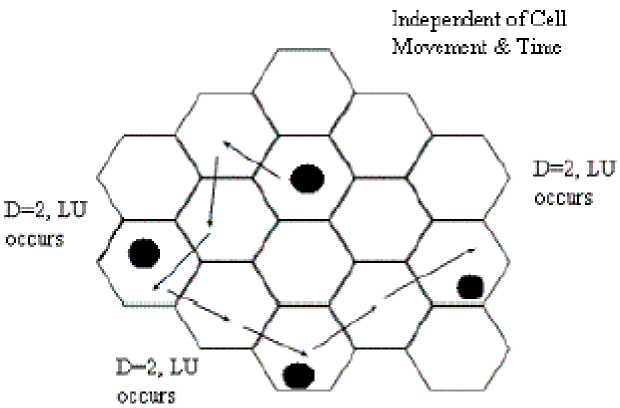

Fig 3 : Distance based threshold Location area update

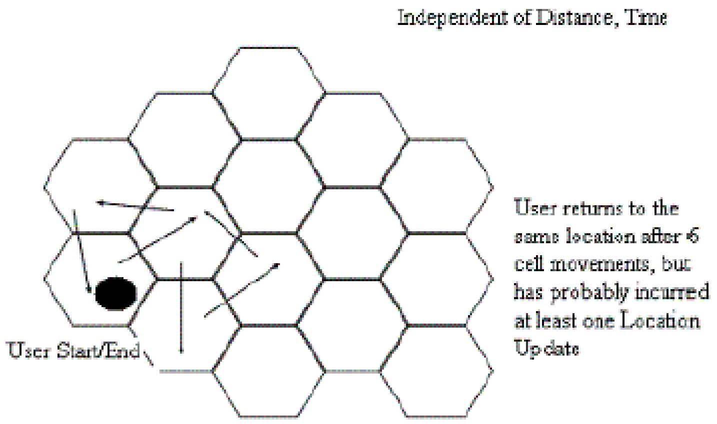

Fig 4 : Cell based threshold Location area update

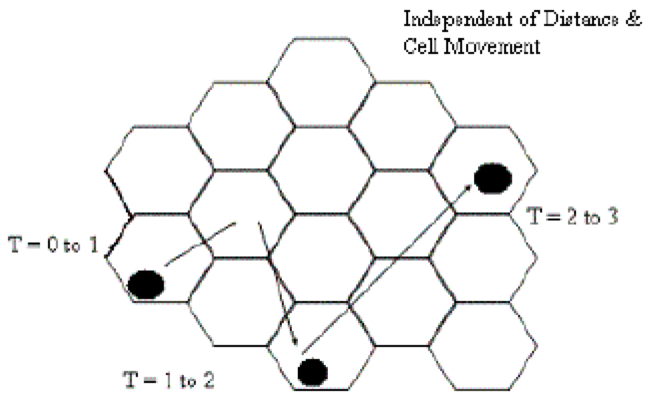

Fig 5 : Time based threshold Location area update

A more sophisticated scheme, built upon the hard work of previous methods, is known as adaptive. Adaptive location update schemes are very flexible and even may differ from each other, as such schemes are intended to take several parameters, such as velocity and mobility model, to determine the most capable location area. In such an example, having information of a user's past actions combined with the user's current pace and direction allows strong analytical power when formative a possible future location for paging. Therefore, location updates may not need to be as regular, thereby reducing the overall location management costs. However, although these adaptive location management schemes are highly victorious in terms of dropping location update costs, they are generally too difficult to realize for large networks, requiring extreme computational overhead. Consequently, dynamic location area schemes must be scrutinized as a possibly preferable solution.

2.2 Hexagonal shaped PCS network

We assume that the PCS network is a homogeneous hexagonal shaped cell configuration, in which all the cells have the same shape (hexagonal) and the same size. The Ring concept for the movement-based location update schemes is as follows. If we take a cell as the center cell, Ring-0 includes only one cell (the center cell). Ring-1 will include all the cells that surround Ring-0, and Ring-1 will be having 6 cells. Similarly, Ring-2 includes all the cells that surround the Ring-1, and so on. We can without difficulty know that Ring-*r* has 6*r* cells apart from that Ring-0 has only one cell, where *r* =0,1,2… all distances are calculated in terms of the number of rings such that the distance from a selected center cell to the cells belonging to set Ring-*r* is *r* rings as shown in Fig 7.

Moreover, the location update engages the update of location data in both VLR and HLR databases. We consider the mobile network with universal hexagonal cell configurations shown in Fig. 7. For the hexagonal cell configuration, cells are hexagonal formed and each cell has six neighbours. There are a lot of rings of cells in the hexagonal cell arrangement. The innermost ring i.e. ring 0, consists of only the center cell in the movement-based location update scheme. Ring “0” is bordered by ring “1”, which in turn is enclosed by ring “2” and so on. We note that in a real network, the cells may have dissimilar shapes and sizes. The rings related with a given centre may have uneven shapes. For demonstration purpose, we assume that uniform cells are used. The *distance* from the center to a cell is calculated in terms of the number of rings from the center cell to the cell. [3]

The size of every cell is known based on the number of mobile channels available per cell and the channel allocation scheme used. The location tracking method can be applied to both the macro cell environment, where cell radius is several kilometres and micro cell environment, where cell radius is in hundreds of meters.

The wireless networks coverage area is segregated into location areas, each of which consists of tens or hundreds of cells and is serviced by a VLR. A mobile terminal resides in a cell it visits for a haphazard time interval and moves on to the next cell.

2.3 Call setup in PCS network

The call setup in wireless communication networks takes place as follows. Caller sends call request message to MSC-VLR through Base Transceiver Station (BTS). VLR checks whether it has replica of called user or not. If replica is there, call appeal is sends to the current VLR of called user through series of VLRs. If not HLR of called user is requested to provide the location of called user and accordingly call setup is made.

In the movement-based location update mechanism, the mobile terminal registers at a new VLR and its new location is reported to HLR when it cross the cells since the last location update, where is a threshold value. For ease, the set of registration and deregistration operations in VLRs is referred to as a *VLR location update* and the location data update in HLR is referred to as a *HLR location update*.

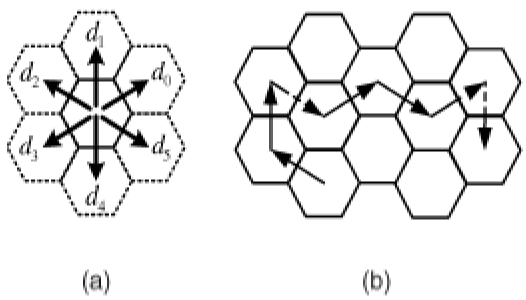

Fig 6 : Movements of the mobile station in a hexagonal cellular system:
(a) six directions and (b) a sample path. [11]

For the movement-based location update method, we define the *centre cell* to be the cell where the last VLR location registration occurred. As soon as a call for a mobile terminal arrives, the network initiates the terminal paging process to locate the called mobile terminal. The paging area is the covering area within a distance from the centre cell. For the system with the static location update scheme, the PA is the same as an LA. [3]

2.4 IS-41 Basic HLR/VLR

The mobile terminal is everlastingly registered with a HLR, under the basic IS-41 HLR/VLR scheme. When the mobile handset enters a fresh VLR area, it sends information to the new VLR which in turn informs its HLR by the means of location update operations. Under IS-41 scheme, the location update operation is performed as follows:

- When the mobile handset enters into a new routing area, it sends a location update message to the current base station which then forwards this message to the current serving VLR.
- The current serving VLR then forwards the message to the hLR of the terminal.
- The home location register (HLR) updates the location information of the mobile terminal and sends an acceptance message jointly with a copy of the mobile terminal profile to the current serving VLR.
- The HLR then sends a location cancellation message to the old serving VLR.
- The old VLR eliminates all entries belonging to the mobile handset and sends the receiving message to the HLR.

When a call is placed to connect to the mobile handset, the PCS signaling network checks with the HLR of the mobile handset to know the current VLR of the mobile handset, a routing request is sent to the current VLR.

A call termination (i.e. call delivery) under IS-41 scheme is performed as follows:

- The calling mobile terminal sends a call initiation message via its base station to its currently serving VLR.
- The VLR decides the connected HLR serving the called mobile handset and sends a location request message to the HLR.
- The HLR determines the callee VLR and sends a route request message to this VLR or MSC.
- The callee VLR passes the route information to the HLR.
- The HLR then sends the route information to the calling VLR. Now, the calling VLR can set up a connection to the callee VLR via the SS7 signaling network using the usual call setup protocol.

There are costs for location update and paging in the dynamic movement-based location management with HLR-VLR architecture. Additionally, in the HLR-VLR network architectures; there are two types of location updates: HLR location updates that update the location data in HLRs and VLR location updates that update the location data in VLRs.

Paging for wireless systems has been well calculated in the literature. However, most of these schemes study how to attain a better performance in terms of cost with or without the paging delay constraint with known location prediction and pay no attention to how to obtain these predictions.

2.5 Total cost calculation for location update

Denote the expected costs per call arrival of HLR location updates, VLR location updates, and the paging by C_{hlr}, C_{vlr} and C_p respectively. The total costs of location update and paging per call arrival is the sum of HLR and VLR location updates and the cost of paging

$$\text{Total Cost, TC} = C_{hlr} + C_{vlr} + C_p \qquad (1)$$

2.5.1 HLR & VLR Total cost calculation

The costs function of location update in database HLR [3]:

$$C_{hlr} = \delta_{hlr} \cdot (\lambda_m / \lambda_c) \qquad (2)$$

The expected cost function of location updates in VLRs per call arrival is obtained as follows [3]:

$$C_{vlr} = \delta_{vlr}\left(\frac{\rho_{sm}^{d}}{1-\rho_{sm}^{d}}\frac{\rho_{mc}}{1-\rho_{mc}} + \frac{\rho_{sc}^{d}}{1-\rho_{sc}^{d}}\right). \qquad (3)$$

Here,

d = cell boundaries (d=1 to d=15)

δ_{hlr} = HLR update cost

δ_{vlr} = VLR update cost

In the analysis, it is assumed that the residence time of a mobile terminal in an LA is an exponential distributed random variable with rate λm and the call arrival to each mobile terminal is a Poisson process with rate λc

Further, we have

$\rho_{mc} = (\lambda m)/(\lambda m + \lambda c)$

$\rho_{sc} = (\lambda s)/(\lambda s + \lambda c)$

$\rho_{sm} = (\lambda s)/(\lambda s + \lambda m)$

where,

$\lambda m = 1/ Tm$

$\lambda s = 1/ Ts$

$\lambda c = 1/ Tc$

T_m is mean LA residence time, T_s is mean cell residence time and T_c is mean time between consecutive phone calls to mobile handset. For brevity, we skip the part of derivation.

In the existing wireless networks, paging process uses a considerable amount of available system resources [1]. To provide a cost effective location management scheme, we need to provide a good trade-offs between the registration process and the paging process. In most of the available LM schemes, MT tells the MS only about its current location without telling whether it can bear a call or not based on its RSS value. Therefore the moment an incoming call arrives, the target MT is paged nonetheless the target MT can bear a call or not. As a result, if target MT is unable to bear a call due to low RSS value then the system resources used in paging it are wasted. This non optimal use of resources puts extra burden on total location management cost.

2.5.2 Paging cost calculation

Now we come to the calculation of the paging cost. The network will search all the range in the location area to find the mobile terminal, when there is a call to arrive at the mobile terminal [7]. The RBPS strategy points to the paging strategies that can be either sequential paging or blanket paging. Both strategies have advantage and disadvantage. In the sequential paging [8], search speed is slow but the paging load is very small. In the Blanket paging [8], search speed is fast but the paging load is very huge. Apart from these two, intelligent paging method has quick search speed as blanket paging and the paging load is small just like the sequential paging.

According to the selective paging scheme, suppose we divide the cells that are at a distance of D -1 from x into c subsets of cells, S1, S2,…, Sc. at First paging the subset s1, if the mobile terminal is found, the procedure of this paging completes and the paging cost will be $|S1| * Cp$ [4]. Otherwise we page the second subset s2, if the mobile terminal is found successfully the cost will be

$$\left(1-\sum_{y\in s_1} P_y(i)\right)\cdot|S_2|\cdot C_p$$

Otherwise, S3 will be paged, if the mobile terminal is found the cost will be

$$\left(1-\sum_{y\in s_1\cup s_2} P_y(i)\right)\cdot|S_3|\cdot C_p$$

This will be repeated until the last subset Sc is searched. The total cost will be

$$Page(i)=|S_1|\cdot C_p+\left(1-\sum_{y\in s_1} P_y(i)\right)\cdot|S_2|\cdot C_p+\left(1-\sum_{y\in s_1\cup s_2} P_y(i)\right)\cdot|S_3|\cdot C_p+\ldots+$$

$$\left(1-\sum_{y\in s_1\cup s_2\cup\ldots\cup s_{c-1}} P_y(i)\right)\cdot|S_c|\cdot C_p$$

2.6 Cost Optimization

The formula is the total cost of the TMS model, we use the location update cost of the first term for the formula.

$$C_T=\frac{1-p}{(2-q-p)}\cdot\frac{1}{d}\cdot C_u+(3(D-1)^2+3(D-1)+1)\cdot C_p\cdot\lambda_c$$

The formula is the total cost of the RBPS model. We use the paging cost of the second term for the formula.

$$C_T = n1 \cdot U \cdot \sum_{i=1}^{\infty} i \cdot \sum_{j=i \cdot d}^{(i+1) \cdot d-1} \alpha(j) + V \cdot \sum_{i=1}^{d} pr\_PACi \cdot \sum_{j=1}^{d} pr\_TCj \cdot \sum_{x=\max(i-j+1,1)}^{\min(i+j-1,d)} \rho_{i,x,j} \cdot nc\_PA_{x,j} \cdot \lambda_c$$

According to above-mentioned, we obtained the formula of the location update cost form the TSM model and obtained the formula of the paging cost from the RBPS. The new formula is ours new strategy.

$$TotalCost = \frac{1-p}{2-q-p} \cdot \frac{1}{d} \cdot Cu + \sum_{i=1}^{d} pr\_PACi \cdot \sum_{j=1}^{d} pr\_TCj \cdot \sum_{x=\max(i-j+1,1)}^{\min(i+j-1,d)} \rho_{i,x,j} \cdot nc\_PA_{x,j} \cdot \lambda_c$$

The first part of the total cost formula is the cost of the location update, the second part is the cost of the selective paging.

Thus, The cost of the selective paging is as follows [2] :

$$\sum_{i=1}^{d} pr\_PACi \cdot \sum_{j=1}^{d} pr\_TCj \cdot \sum_{x=\max(i-j+1,1)}^{\min(i+j-1,d)} \rho_{i,x,j} \cdot nc\_PA_{x,j} \cdot \lambda_c \qquad (4)$$

where ,

$\rho_{i,x,j}$ = probability for an MT to move from i^{th} PA to x^{th} PA.

nc_PAx = Number of cells in the x^{th} PA

λc = inverse of the mean time between two consecutive phone calls to MT

CHAPTER – 3

Proposed method

3.1 Mobile Platforms

Each mobile platform is functionally equal for the end user. Each mobile has some set of common features like making call, sending messages, saving the files and so on. However, apart from these common tasks, there is more for the mobile device to perform. Each mobile platform has specific development environment and hence each of the environment supports very specific programming languages and the APIs. There are various mobile platforms in the market nowadays like Android, Blackberry, iOS etc and each of this has a specific and rich set of UI and APIs. And this specific combination makes them robust in comparisons to each other. Some mobile platforms are more robust in comparison to other while some other lacks the edge over the other mobile platform. These specific specifications make them stable in comparison to other. As we can see in today market scenario that Apple's iOS is most robust in terms of rich set of APIs and the full loaded features. Though iOS is among the most robust mobile platform in the market today, but it lacks the openness to the developers to develop and debug the application.

On the other hand, the Android mobile platform which is an advanced mobile platform now, had a rich set of development tools and having outstanding performance in today's time. This mobile platform has its charm because of the fact of usability and to cope up with today's more advanced mobile platforms. Today's mobile platform runs a lot of applications and they are the best example of the mobile multitasking where Android platform is not lacking at all in its whole eco system. There was vast scope for the OEMs to develop their own application of that and hence the hindrance was negligible when compared to the new and other OS in the market like Windows, BlackBerry etc. Not only about the application part, but the mobile platform has to conquer the power management and the network scanning part also. The mobile platform of the today's world meets the requirement of the swift customer. Today's mobile platforms are able to perform the tasks more reliable as compared to the smart phone of few years back.

The choice of the mobile platform is the demanding need of the today's user. Today, the market is time sensitive and the demand of the end user is increasing day by day. The smart phones are entering into our lifestyle and are becoming indispensable tool. So, the performance of the mobile device is increasing and getting demanding day by day.

The means of the telecommunication are increasing day by day as the evolution of the mobile handsets is increasing. And with all these, the new question is also coming up related to the security, stability and sociability of the mobile platforms and OEMs has also come up with their own innovations to attract the end user.

Ideally, the mobile terminals are the means where the software codes are executed and codes are the mean of interaction among the hardware and the user. The basic GUI is the look and feel of the software code. The codes are actually endorsed as the emerging technology and the compatibility of the code and the hardware matters a lot. There are many part of the application which always runs on the mobile hardware without the knowledge of the end user like power management, mobility management, load balancing, device driver loading and unloading among others. These can be interpreted in many ways like mobility management can be helpful in reducing the call setup time, the power management can be useful in enhancing the batter life, device driver loading may affect the processor performance and so on.

The objective of this chapter is very clear and that is to present the performed research in the very clear manner, with the description of the original work. In the direction for the same, the attempt was made to highlight the significant work in lucid manner. The thesis is related the mobility management of the mobile devices and in this direction, the location management is the important aspect. This is crucial part of the mobile communication and the quality of service plays a vital role here. In the last few years, various methods were proposed regarding the location update mechanism and here we tried to develop the efficient location update mechanism considering the selective paging.

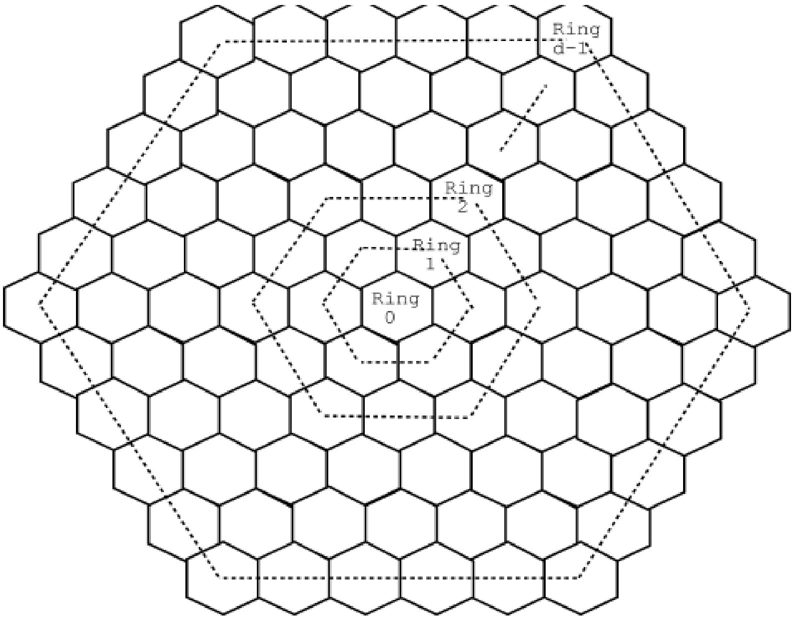

Fig 7 : The hexagonal configuration [3]

3.2 Research Approach

Each research work can be distinguished in two ways. One is analytical and another one is practical. In the analytical research, data and other important facts that affect the project is accumulated; after the information is collected and evaluated, the sources are used to prove. Analytical research is used to find supporting evidence to current research being done in order to make the work more reliable. Moreover, analytical research is conducted in a variety of ways including literary research, public opinion, scientific trials and meta-analysis. The latter, Practice research is a form of academic research which incorporates an element of practice in the methodology or research output.. Each approach has its own advantages and disadvantages. These models may be too complex to implement actually. On other hand, these models may be too simple so that they are not able to consider all the aspects and thus the consequences may not be safe.

In the current thesis, the analytical work is chosen and the thesis put the importance on the real world usability and the effectiveness of the study. In the thesis the two approaches are studied and created a conclusion which is the basic of the proposed thesis. The thesis is planned carefully and designed to support the accumulation of all the data to meet the specific objective to reduce the total cost of the location update.

The efficiency of the proposed location management scheme is evaluated using an analytical model, which is compared by earlier study from Jian-Ming Chang, Chi-Yuan Chang, Tzu- Hua Lin,Han-Chieh Chao. [1]

3.3 Limitations of the earlier studies

In the earlier study, the location update mechanism is performed when the mobile terminal crosses the particular number of the cells i.e. the location area update procedure was performed when the cell threshold was reached [1]. So the location update was performed when the mobile terminal surpasses the earlier defined value of the threshold. The consideration of the home location register cost and the cost for the visitor location register was not considered.

Moreover, it was being observed that the cost of paging was kept constant in the HLR-VRC architecture based study and that is not changing at all [3]. That was the major limitation because the cost of a HLR and the cost of VLR were variable whereas the cost of paging was kept constant. The blanket paging was being used in earlier study where the entire cells are polled together but which is wasteful use of the network resources.

To overcome above mentioned problem, it is being proposed in this current study to select the scheme which is intelligent enough in the field of paging and the cost of HLR-VLR is also into the consideration during the calculation of the dynamic location update cost.

In the selective paging mechanism, the network divides the residing area of the called mobile user in a number of sub areas these sub areas are then paged till the mobile terminal is found. Means the first subset is paged and if the mobile terminal is found in that subset then procedure with stop there otherwise it will be the next subset and this process will keep going on in all the subsets till the specific mobile terminal is found. In this way we can have an intelligent paging scheme which was not the case in earlier yesterday earlier studies.

We can summarize the selective paging scheme as follows:

1) Sending the paging to the set of cells to find the target mobile device and wait till the desired mobile terminal is found.
2) If the acknowledgement is found within the time frame, the desired mobile terminal is within the targeted cell.
3) If the acknowledgement is not received, the mobile terminal is no in the cell and the step 1 is repeated for the next paging area.

Hence, selective paging is boon here, where the network first divides the residing area of the called mobile user in a number of sub sets. These sub-sets or rather sub-areas are polled thereafter till the mobile terminal is found.

3.4 Proposed System Model description

Usually, the paging area is the area with distance of 'd-1' form the center cell. But in the dynamic location management methods, the size of the location area is fixed whereas the size of the paging area changes as shown in the Fig 8.

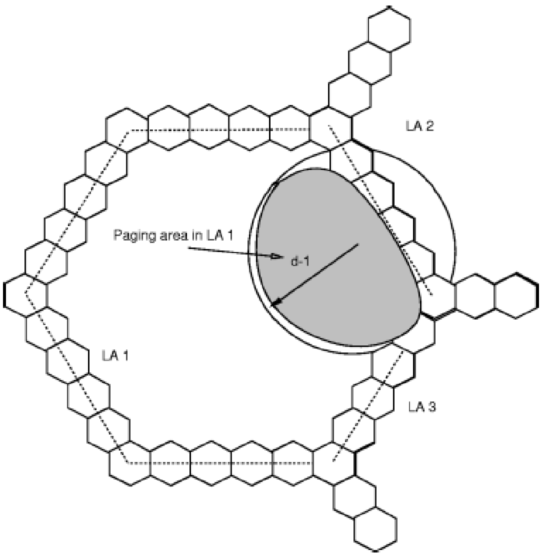

Fig 8 : The PA in an LA with movement-based location update scheme [3]

Let us try to understand the selective paging by the mean of timing diagram in the Fig 9. It is being shown in the figure that when mobile terminal is at point A, it receives a MT call. Here the mobile terminal is at paging area '0' (PA0). If the mobile moves to point B from A, it is in paging area 1 (PA1) or PA0. If the mobile terminal moves to point D, it might have moved from PA0, PA1 or PA2. In such scenario, the mobile terminal is to be paged in the current and the next paging area sequentially. The decision table for the same is as shown in the Fig 10.

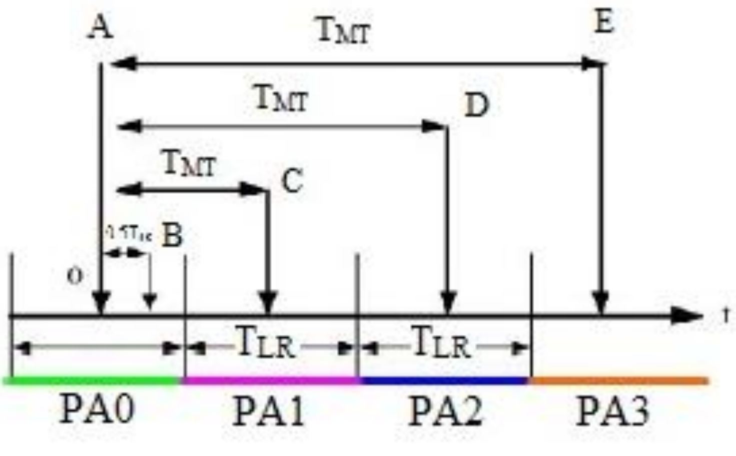

Fig 9 : The timing diagram

Here, the location area residence time T_{LR} is assumed to be identically distributed, but which may not be the case usually. Further, inter call arrival time T_{MT} also follows an exponential pattern. T_{CR} is considered as mean cell residence time. Here the advantage of the selective quite evident that instead of searching the whole cell area, the mobile terminal is being searched in the special paging area sequentially.

Mobile Terminal Distance moved	**Paging Area**
$T_{MT} < 0.5T_{LR}$	Paging PA0
$05T_{LR} \le T_{MT} \le 1.5T_{LR}$	Paging PA0+PA1
$1.5\ T_{LR} \le T_{MT} \le 2.5\ T_{LR}$	Paging PA0+PA1+PA2
$T_{MT} \ge 2.5\ T_{LR}$	Paging PA0+PA1+PA2+PA3

Table 1: The decision table

In the HLR-VLR architecture, the calculation of the VLR update cost is assumed to be critical part of the calculation because the cost has to be calculated while considering the movement of the mobile terminal in the paging area and also in the location area, where location area is fixed but the paging area keeps changing. With the help of the timing diagram as shown in the Fig 9 above, we can obtain the probability that mobile terminal crosses ‘k’ cell boundaries within one particular location area (which maybe set of many paging areas)[3]. For the brevity, the derivation part [3] is skipped here. For the sake of calculation simplicity, let us take :

$$T_{LR/CR} = (T_{LR})/(T_{CR} + T_{LR}) \quad (5)$$

$$T_{MT/LR} = (T_{MT})/(T_{LR} + T_{MT}) \quad (6)$$

$$T_{MT/CR} = (T_{MT})/(T_{CR} + T_{MT}) \quad (7)$$

The wireless communication is a complex system. The scope of this thesis is limited to the efficiency of the mobility management, and more precisely to the overall cost of the location update in the wireless communication. In the wireless communication, the performance can be taken into account on to the different levels, but here, only the location management performance is taken into the consideration. There are many other factors related to the location management like the terrain, the geography, the number of cell sites, the congestion of the end users, the particular protocol stack used and so on. Some assumptions are made in the current thesis which are not directly impacting the study and not involved the performed thesis. The various variables used in the study are given in Table 2 .

Variables	**Description**
D	Cell boundaries.
$P_{MT(I,j)}$	Probability for an mobile terminal to move from i^{th} PA to j^{th} PA.
$N_{cell(j)}$	Number of cells to be polled in the j^{th} paging area
n	Number of rings in the j_{th} PA
HLR_{UC}	HLR update cost
VLR_{UC}	VLR update cost
T_{MT}	Mean time between two consecutive phone calls to mobile handset i.e. time elapsed between termination of a call and arrival of the next call to the mobile handset
T_{CR}	Mean cell residence time.
T_{LR}	Mean location area residence time
pr_PAC_i	Probability that the ith PA is the current PA.

Table 2 : The various variables used in the study

The protocol stack in the particular mobile terminal used to handle many important tasks and it plays the important role in the mobile to network communication and it has to be backward compatible always due to the reason of fast changing wireless technology. As it is evident that, initially we had GSM, then came the era of UMTS and recently we have seen the emergence of LTE network all around. These all technology should ensure that the stack in compatible with each other. There may be the problem in the same but overall location based bottleneck should be minimized so that the update cost is minimal. The cost is mainly the time taken for performing the each operation, the time taken in the operation like call setup time, the number and the size of the messages sent and received, the distance of these messages need to travel etc.

3.5 System Implementation

It is always vital to consider the most important parameters into the consideration while calculating the total cost of location area update and they are the paging cost and the location update cost. It is evident that the size of the paging area is flexible whereas the size of the location area is fixed in the current study of the dynamic location management. And this variation makes the study bit difficult to conclude. Here, in this section, an attempt is made to provide the cost function of the total cost of the location management. This study sums up the cost function of the HLR, VLR and the selective paging scheme.

Based on the discussion in the previous chapter 2, the total cost for the dynamic movement based location management with HLR-VLR architecture with the selective paging is as shown follows.

Selective Paging Total Cost,

$$C_{paging} = \sum_{d=2}^{n} \{ P_{MT(j,j)} \} * \{ N_{cell(j)} * T_{MT} \} \tag{8}$$

The cost function for location update in database HLR is given as,

$$C_{hlr} = HLR_{uc} * \frac{T_{MT}}{T_{LR}} \quad (9)$$

The cost function for location update in database VLR per call arrival is as follows,

$$C_{vlr} = VLR_{UC} \cdot \left(\frac{T^{d}_{LR/CR}}{1 - T^{d}_{LR/CR}} \right) \left(\frac{T_{MT/LR}}{1 - T_{MT/LR}} \right) + \left(\frac{T^{d}_{MT/CR}}{1 - T^{d}_{MT/CR}} \right) \quad (10)$$

Another important aspect in this study is the call to mobility ratio and which can be used to access the mobility of the mobile terminals. The call to mobility ratio is defined as the ratio of average cell residence time and the average time between the two successive phone calls to the mobile device [3] or as the ratio of the average location area residence time and the average time between two successive phone calls to a mobile device [3]. We understood from this point that the smaller call to mobility ratio means higher mobility of the user. Hence, we conclude form this point that the higher mobility of the mobile terminal means shorter mean time interval. In other words, higher mobility of the mobile user denotes the smaller call-to-mobility ratio.

In this thesis, the cell residence time is depicted by the shape and size of a cell. Mean residence time would be smaller in the small cell and the vice versa. In the live mobile communication, whenever there is instance of the mobile terminated call, the mobile terminals are paged all together, which as mentioned earlier, is the waste of the limited wireless resources. Hence a selective paging scheme can be used. In the selective paging scheme, the mobile device is paged on the basis of the probability metric as discussed earlier in chapter 2.

3.6 The calculations

The calculation part for the study was complex and variables which are taken into consideration are as mentioned in the table 2. The calculation part is summarized here in the set of three tables. Table 3 displays the data set when the HLRuc and VLRuc was 20 each but T_{MT} is 10.

d	1	2	3	4	5	6	7
HLR_{UC}	20.000	20.000	20.000	20.000	20.000	20.000	20.000
VLR_{UC}	20.000	20.000	20.000	20.000	20.000	20.000	20.000
T_{MT}	10.000	10.000	10.000	10.000	10.000	10.000	10.000
T_{LR}	1800.000	1800.000	1800.000	1800.000	1800.000	1800.000	1800.000
T_{MT}/T_{LR}	0.006	0.006	0.006	0.006	0.006	0.006	0.006
C_{hlr}	0.111	0.111	0.111	0.111	0.111	0.111	0.111
$T_{LR/CR}$	0.938	0.938	0.938	0.938	0.938	0.938	0.938
$T_{MT/LR}$	0.006	0.006	0.006	0.006	0.006	0.006	0.006
$T_{MT/CR}$	0.077	0.077	0.077	0.077	0.077	0.077	0.077
C_{vlr}	3.333	0.925	0.529	0.378	0.292	0.235	0.195
pr_PACi	0.900	0.810	0.720	0.640	0.570	0.510	0.450
pr-TCj	0.900	0.810	0.720	0.640	0.570	0.510	0.450
$P_{MT(I,j)}$	0.167	0.167	0.167	0.167	0.167	0.167	0.167
N	6.000	9.000	12.000	15.000	18.000	21.000	24.000
C_{paging}	0.081	0.732	2.663	6.611	13.276	23.297	37.104
$Cost_{total}$	2.885	0.796	1.025	1.682	2.619	3.800	5.180

Table 3 : HLRuc =20, VLRuc = 20, T_{MT} = 10.

Table 4 displays the data set when the HLRuc and VLRuc was 20 each but T_{MT} is 1. Here the repeated values are not shown which are common with table 3 above.

D	1	2	3	4	5	6	7
T_{MT} / T_{LR}	0.001	0.001	0.001	0.001	0.001	0.001	0.001
$T_{MT/LR}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001
$T_{MT/CR}$	0.008	0.008	0.008	0.008	0.008	0.008	0.008
C_{vlr}	0.333	0.082	0.052	0.038	0.029	0.023	0.019
C_{paging}	0.812	7.325	26.625	66.106	132.761	232.969	371.041
$Cost_{total}$	1.131	3.668	8.831	16.447	26.443	38.691	52.842

Table 4 : HLRuc =20, VLRuc = 20, T_{MT} = 1

Table 5 displays the data set when the HLRuc is 10 , VLRuc is 5 and T_{MT} is 100. Here the repeated values are not shown which are common with table 3 above.

D	1	2	3	4	5	6	7
T_{MT} / T_{LR}	0.001	0.001	0.001	0.001	0.001	0.001	0.001
$T_{MT/LR}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001
$T_{MT/CR}$	0.008	0.008	0.008	0.008	0.008	0.008	0.008
C_{vlr}	0.333	0.082	0.052	0.038	0.029	0.023	0.019
C_{paging}	0.812	7.325	26.625	66.106	132.761	232.969	371.041
$Cost_{total}$	1.131	3.668	8.831	16.447	26.443	38.691	52.842

Table 5: HLRuc = 10 , VLRuc = 5 and T_{MT} = 100

3.7 The output

The total cost for location update mechanism for the proposed and the previous scheme are as shown below for the values of T_{MT} as 10, 1 and 100 respectively.

T_{MT}=10							
Proposed scheme	2.885	0.796	1.025	1.682	2.619	3.8	5.18
Previous scheme	0.4	0.5	0.9	2.5	4	6	8

T_{MT} =1							
Proposed scheme	1.131	3.668	8.831	16.447	26.443	38.691	52.842
Previous scheme	1	5	15	22	40	60	82

T_{MT}=100							
Proposed scheme	4.853	1.393	0.689	0.493	0.465	0.515	0.609
Previous scheme	0.5	0.2	0.3	0.4	0.5	0.7	0.9

The graphs of the above calculations are explained in the next chapter.

3.8 Limitation of the work

The wireless resources are very limited in the live scenario and every attempt should be made to save the same. When location update procedure is executed in the live network and in the HLR and VLR infrastructure, the bandwidth utilization and the computational resources are used extra in comparison of the polling the mobile devices stand alone. Thus, the cost of polling a cell ideally should be less that the cost of performing the HLR and VLR location update cost.

The time taken in the operation like call setup time, the number and the size of the messages sent and received, the distance of these messages need to travel etc. are the parameters which also affects the overall performance of the system.

The variables in the thesis are used to analyze the result of new scheme and they are evaluated in comparison to the old scheme. The total cost obtained from the proposed scheme is compared with the previous scheme. The Fig 7 shows the commonly used hexagonal cell structure of the widespread wireless communications. The hexagonal configuration has many cells and each cell is surrounded by the six another cells. The deepest cell (0) consists of just inside cell in the moment based location update scheme. The cell-1 encircles the cell 0 and which in turn is bounded and so on.

CHAPTER -4

Performance comparison

The efficiency of the proposed location management scheme is evaluated using an analytical model, which is compared with the earlier study by Jian-Ming Chang, Chi-Yuan Chang, Tzu- Hua Lin,Han-Chieh Chao [1]. The proposed location management scheme incorporated the HLR-VLR architecture [3] and selective paging cost in the dynamic movement-based location management [1].

The model offered in the chapter 3 details the performance details and assessment of the movement based locates mechanism, under various parameters. Here, few typical variables are used and the details of each parameter are given under the table 2.

4.1 System model description

In the proposed hybrid scheme, the selective paging [1] is used along with the dynamic movement-based location management cost with HLR-VLR architecture [3]. Thus, under the combined scheme, the total cost is represented as:

$$\text{Total Cost, } TC = C_{vlr} + C_{paging} + C_{hlr}$$

$$TC = \left[VLR_{UC} \cdot \left(\frac{T^{d}_{LR/CR}}{1 - T^{d}_{LR/CR}} \right) \left(\frac{T_{MT/LR}}{1 - T_{MT/LR}} \right) + \left(\frac{T^{d}_{MT/CR}}{1 - T^{d}_{MT/CR}} \right) \right] + \left[\sum_{d=2}^{n} \{ P_{MT(i,j)} \} * \{ N_{cell(j)} * T_{MT} \} \right] + \left[HLR_{uc} * \frac{T_{MT}}{T_{LR}} \right]$$

In the previous mechanism, the mobile terminal perform the location update when it crosses the threshold value of the number of cells 'd'. If the number of crossing the cell is more than the define threshold value, the mobile terminal will perform the location update. Here, location management scheme using the HLR-VLR architecture with the selective paging mechanism is used. In the selective paging, the network firstly selects a set of cells for the purpose of paging and the paging signal is sent to these sets of cells, If the desired mobile terminal is found, the paging is terminated, else the polling of the paging is sent to next set of cells and this process keeps on till the desired mobile terminal is not found.

4.2 Results and discussion

The total cost acquired from the new scheme and the previous schemes are evaluated here. The costs of different boundary crossing threshold "d" are assessed when T_{MT} =10 & 1 i.e. time elapsed between termination of a call & arrival of the next call to mobile handset is 10 and 1 respectively.

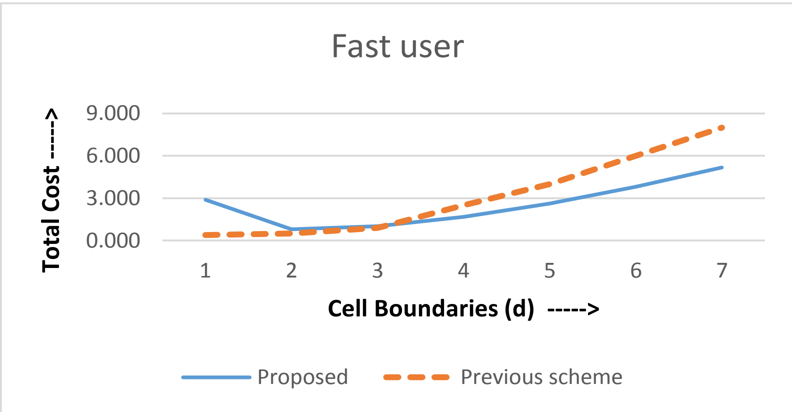

Fig 10 : Cost at various boundaries when T_{MT} = 10

Figure 10 shows that the location update cost is high when the value of d is 1 (i.e. the location update count). Thereafter, the location update decreases when d ranges from

2 to 7. With the increase in the d value, there is reduction in the number of location update and there is also the plunge in the location update cost step by step.

However, increase in the value of d would cause the paging area to increase also, and thus increase the paging cost. The scheme proposed here still has good performance in d = 2 to 7. In addition to this, the numerical results demonstrate that the proposed scheme surpass the previous scheme. When the threshold'd' ranges from 2 to 7, it is evident that the total location update cost of new strategy is lower than the previous scheme.

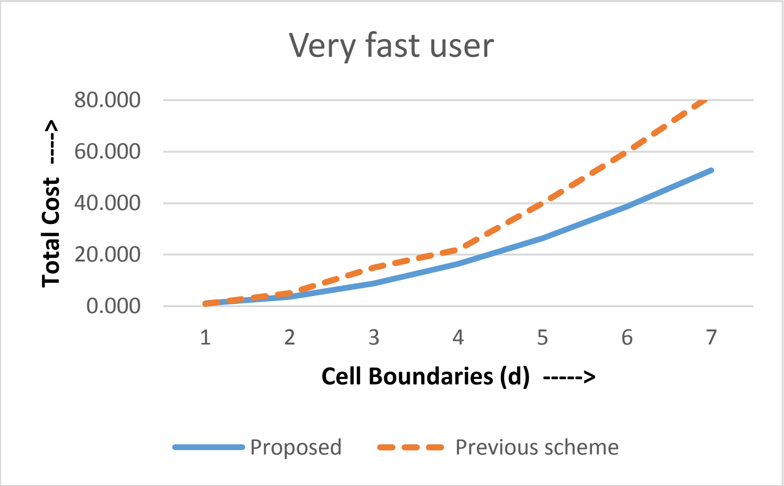

Fig 11 : Cost at various boundaries when $T_{MT} = 1$

From Fig.11 & 12, we could see that the proposed strategy has better performance than the previous scheme when d ranges from 2 to 7.

From Fig.12, we could see that the proposed strategy has surpassed the previous scheme when d ranges from 5 to 7. Here, the HLR update cost and the VLR cost is changed to 10 and 5 respectively. We came to the conclusion that as the VLR update cost reduces, the total cost also gets reduced when d is in between 5 to 7, which in the indication that VLR cost has significant impact on the total location cost and which was not considered in the previous scheme.

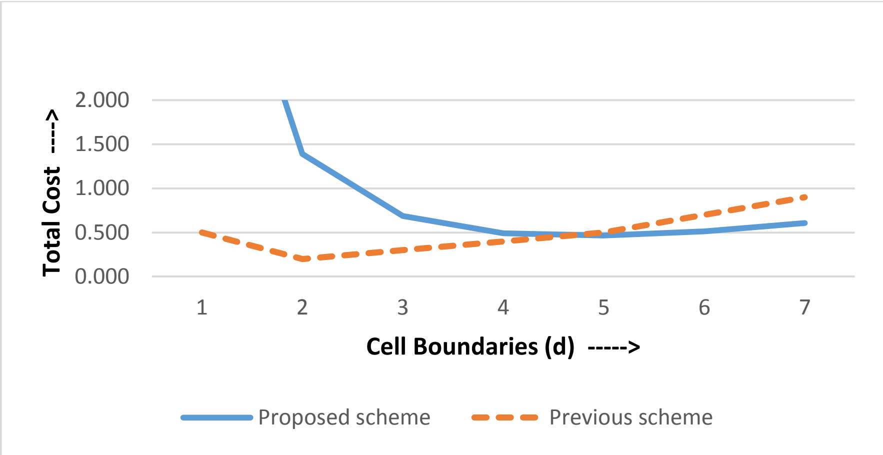

Fig 12 : Cost at various boundaries when T_{MT} = 100

It is evident from the graph that there is decrease in the performance improvement when T_{MT} increases. This is normal because with the lesser mobility (i.e., the larger value of T_{MT}), it is better not to perform the registration operation regularly and vice versa. From the graphs, it is obvious that the value of d also decreases as the cost decreases. It is expected because an increase in the movement threshold results in an increase of the paging area of the mobile terminal and, thus, decreases the HLR and VLR update costs.

The numerical experiments with different system parameters are broadly conducted. We provide the typical results here.

CHAPTER -5

Conclusion & Future Scope

5.1 Conclusion

In the thesis, the efficiency of the proposed location management scheme is evaluated using an analytical model, which is compared the earlier study by Jian-Ming Chang, Chi-Yuan Chang, Tzu- Hua Lin,Han-Chieh Chao [1]. The performance of the proposed location management scheme is evaluated in terms of the HLR-VLR architecture [3] and selective paging cost in the dynamic movement-based location management [1] and found to be efficient comparatively.

So far, we have seen that the significance of the location management is of utmost importance in the wireless communication. Here, we have seen the difference in the performance when the selective paging is used in spite of the blanket paging during the mobile terminated call. Also, for the location update cost, threshold value is not used, rather the cost of HLR and VLR is taken into consideration. Overall, the mobility management can be studied in two separate streams i.e. the location update and the paging. In the proposed study, these two are also explained in depth.

The proposed method is simple to use and by using this scheme; the performance is evaluated and compared with the previous scheme. When we compare the proposed scheme with the previous scheme, we have seen that better results are obtained under the same environment comparatively. We observed that the location cost reduces successfully when using the proposed mechanism in the mobility and calling pattern under various parameters. Finally, the total cost is reduced and the performance is better, as evident from the various graphs above. The new scheme is beneficial in reducing the total cost consisted of the paging cost, the HLR cost and the VLR cost of the terminal.

The proposed scheme enabled us to reduce the amount of the paging to the mobile terminals. Also the scheme is beneficial if implemented in the limited population size. Also, we can see that the processing overhead in also minimal in the proposed scheme. If we consider the random movement of the users in the live network, we can see that the proposed methodology can be used there also. As evident, the proposed scheme is more advantageous when compared to previous scheme and can be used in the real network with minor upgradations.

5.2 Future scope

This scheme gives us good analysis of the design and implementation of the location update using the selective paging in the cellular networks. The accuracy of the proposed model can be verified using the computer simulation and ideally, the result thus obtained should match with the proposed scheme. Computer simulation can integrate more minute detail while studying the performance elevation of the mobility management in the cellular networks. Moreover, several parameters, such as velocity and mobility model, information of a user's past actions, the user's current pace and direction allows strong analytical power when considering the possible future scope.

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