Location Management Strategies in Mobile Networks

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Abstract—Global system for mobile communication (GSM) is globally accepted standard for digital cellular communication. GSM user uses a GSM based phone which is mobile. To identify the exact location of GSM user is a complex problem as user frequently moves between the cells. Location management deals with how to keep track of an active mobile station within cellular network. There are two basic operations involved with location management location update and paging. Through operation we find the location of mobile station. This paper analyze the location management techniques for GSM

Index Terms—*Mobile Communication, Location management, GSM, paging*

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I. INTRODUCTION

The exact location of the MS is not currently known in the GSM network. During a call thus serving Base Transceiver Station (BTS) is known and thus the location of the MS is known within an accuracy of one cell. So there is a need to locate the MS more exactly. [1]

Location management is initiated by the mobile unit using the reverse channel whenever it enters into the new location area. Location area represents a cluster of cell that is connected with same MSC[2]. In cellular subscriber base necessarily leads into cell size reductions and in user density increase. The planned evolution of current systems will demand a much higher number of operational procedures and a corresponding increase in signalling load. Besides, the desire of providing worldwide roaming has critically increased the importance of efficient paging and location update algorithms.[2]

In this paper we are trying to find the exact location of user through the GSM services and using some techniques for location identification and management. We can consider an example related to location management. Suppose if there are 500 employees working in a company and the company provides one cell phone to each employee. Now if all cell phones are connected to only one BTS say BTS-A, it becomes easy for the company to know about the employee whether he/she is within the network or not. Since there were 500 employees, we know that there are 500 people connected to network. Now suppose if any employee is going outside the range of the BTS-A then he/she will be

disconnected by the BTS-A and will not be counted in the list of connected people. Now the head of the company knows that some employees are not working presently and are busy somewhere outside the company network. This technology can be beneficial for company as employees will always try to be in the network. It is helpful where employees are not sincere about their work and not present in the firm like in industries related to production, mills etc. Rest of the paper is organized as follows: In the section II discuss global system mobile communication (GSM). In section III discuss handover, types of hand over. We discuss about the location management, and techniques to identify location of user in section IV. And section V provide concluding remarks

2. GLOBAL SYSTEM FOR MOBILE COMMUNICATION

GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specification for a pan-European mobile cellular radio system operating at 900 MHz

GSM is a TDMA based wireless network technology developed in Europe that is used throughout most of the world. GSM phone make use of a SIM card to identify the user's account. The use of SIM card allow GSM network user to quickly more their phone number from one GSM phone to another by simply moving the SIM card. Currently GSM network operate on the 850 MHz, 900 MHz, 1800 MHz

and 1900 MHz frequency band. Devices that support all four band is called quad band with those that support 3or 2 band called tri-band and dual-band respectively. In the United States, Cingular operates on the 850and 1900 MHz bands. While T-Mobile operates only the 1900 MHz band. A GSM network is made up of multiple component and interface that facilitate sending and receiving of signaling and traffic message it is a collection of transceiver, controller, switch, router and register. As shown in fig. 1 GSM consist units. Some of them are briefly describe below.

Mobile station

A mobile station may be referred to as a handset, a mobile, portable terminal or mobile equipment ME). It also includes a subscriber identity module (SIM) that is normally removable and comes in two sizes. Each SIM card has a unique identification number called IMSI (international mobile subscriber identity). In addition, each MS is assigned a unique hardware identification called IMEI (International Mobile Equipment Identity).
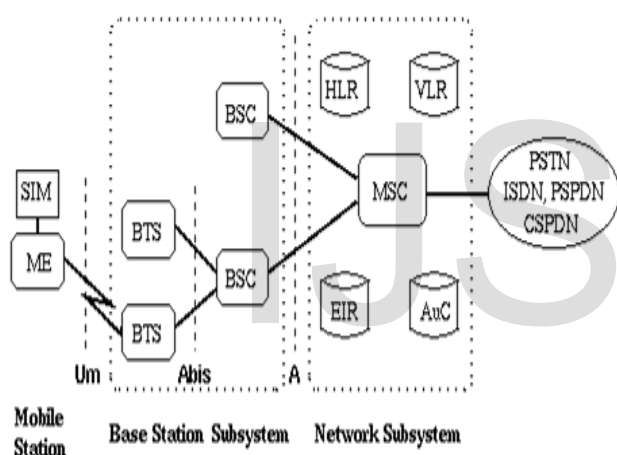

Fig. 1. GSM Architecture

Base Station Subsystem (BSS)

The BSS is made up of the base station controller (BSC) and the base transceiver station (BTS).

Base Transceiver Station (BTS)

The base transceiver station (BTS) GSM uses a series of radio transmitters called BTSs to connect the mobiles to a cellular network. Their tasks include channel coding/decoding and encryption/decryption. A BTS is comprised of radio transmitters and receivers, antennas, the interface to the PCM facility, etc. The BTS may contain one or more transceivers to provide the required call handling capacity

Base Station Controller (BSC)

A group of BTSs are connected to a particular BSC which manages the radio resources for them. Today's new and intelligent BTSs have taken over many tasks that were previously handled by the BSCs. The primary function of the BSC is call maintenance. The mobile stations normally send a report of their received signal strength to the BSC every 480 ms. With this information the BSC decides to initiate handovers to other cells, change the BTS transmitter power, etc

Mobile Switch Centre (MSC)

Acts like a standard exchange in a fixed network and additionally provides all the functionality needed to handle a mobile subscriber. The main functions are registration, authentication, location updating and handovers as well as call routing to a roaming subscriber.

Home Location Register (HLR)

A database used for management of mobile subscribers. It stores the international mobile subscriber identity (IMSI), mobile station ISDN number (MSISDN) and current visitor location register (VLR) address. The main information stored there concerns the location of each mobile station in order to be able to route calls to the mobile subscribers managed by each HLR. The HLR also maintains the services associated with each MS. One HLR can serve several MSCs

Visitor Location Register (VLR)

VLR Contains the current location of the MS and selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently located in the geographical area controlled by the VLR. A VLR is connected to one MSC and is normally integrated into the MSC's hardware.

Authentication Centre (AuC)

A protected database that holds a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and encryption over the radio channel. The AuC provides additional security against fraud. It is normally located close to each HLR within a GSM network

Equipment Identity Register (EIR)

The EIR is a database that contains a list of all valid mobile station equipment within the network, where each mobile station is identified by its international mobile equipment identity (IMEI). The EIR has three databases:

- White list: for all known, good IMEIs

- Black list: for bad or stolen handsets
- Grey list: for handsets/IMEIs that are uncertain

3. HANDOVER

Cellular system requires handover procedures, as single cell do not cover the whole services area, but e.g., only up to 35 km around each antenna on the country side. The smaller the cell size and the faster the movement of a mobile station through the cell (up to 250km/h for GSM), the more handovers of ongoing calls are required. However, a handover should not cause a cut-off, also called call drop.GSM aims at maximum handover duration of 60 ms [9]

Two basic reasons for a handover

- The mobile station moves out of range of a BTS or a certain antenna of a BTS respectively. The received signal level decreases continuously until it falls below the minimal requirements for communication .The error rate may grow due to interference , the distance to the BTS may be too high (max. 35 km) ,these effect may diminish the quality of the radio link and radio transmission impossible in the near future.
- The wired infrastructure (MSC, BSC) may decide that the traffic in one cell is too high and shift some MS to other cells with a lower load (if possible).Handover may be to load balancing.

Types of Handover
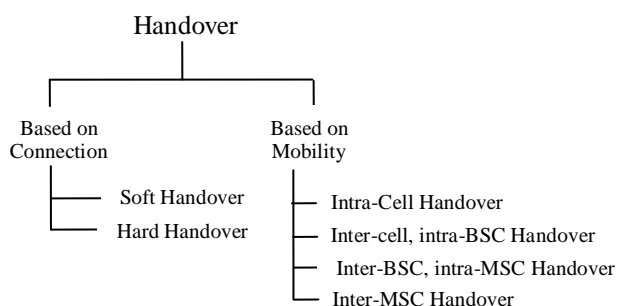 I.   Based on Connection
 II. Based on Mobility

Figure 2. Types of Handover

Based on connection

Soft handover: (Get before release) Soft handover means that the radio links are added and removed in a way that the UE always keeps at least one radio link to the UTRAN .Soft handover is performed by means of macro diversity,

which refers to the condition that several radio links are active at the same time .Normally soft handover can be used when cells operated on the same frequency are changed .

Hard handover: (Release before get) Hard handover means that all the old radio links in the UE are removed before the new radio links are established. Hard handover can be seamless or non-seamless. Seamless hard handover means that the handover is not perceptible to the user. In practice a handover that requires a change of the carrier frequency (inter-frequency handover) is always performed as hard handover. [10]
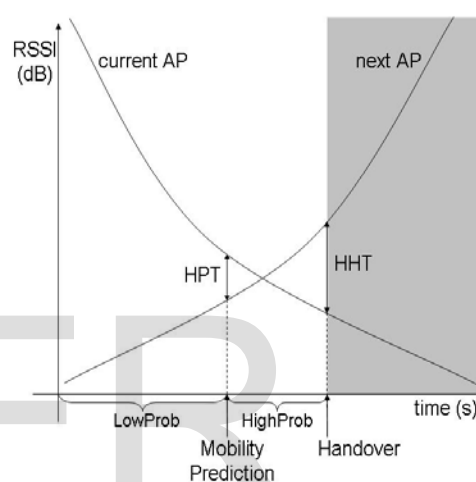
Figure 3 Handover

Based on Mobility

 Four types possible handover scenarios in GSM

   Intra-cell handover: Within a cell, narrow-band interference could make transmission at a certain frequency impossible. The BSC could then decide to change the carrier frequency

   Inter-cell, intra-BSC handover: The mobile station moves from one cell to another, but stays within the control of the same BSC .The BSC then perform a handover assign a new radio channel in the new cell and release the old one.

   Inter-BSC, intra-MSC handover: As a BSC only controls a limited number of cells; GSM also has to perform handovers between cells controlled by different BSCs. This handover then has to be controlled by the MSC

   Inter MSC handover: A handover could be required between two cells belonging to different MSCs. Now both MSCs perform the handover together.

4. Location Management

Location management includes three strategies: location prediction, update and paging. Location management schemes are essentially based on users' mobility and incoming call rate characteristics. The network mobility process has to face strong antagonism between its two basic procedures: location and paging. The location procedure allows the system to keep the user's location knowledge, more or less accurately, in order to be able to find him, in case of a coming call, for example. Location registration is also used to bring the user's service profile near its location and allows the network provide him rapidly with his services. The paging process achieved by the system consisting of sending paging messages in all cells where the mobile terminal could be located. Therefore, if the location cost is high (and thus the user location knowledge is accurate), the paging cost will be low (paging messages will be only be transmitted over a small area) and vice versa.

Techniques

Location prediction

Location prediction is an active dynamic strategy, which forecasts a mobile node's location based on this node's movement model. One way to know the future location of a mobile node is to require the mobile node to indicate its destination and speed; we can employ this node's future destination and current speed to calculate its future location [2]. Unfortunately, in some scenarios, the mobile node does not know its destination or next direction. Some researchers have proposed some mobility prediction algorithms Liu and Maquire proposed an aggressive mobility management scheme, in which an algorithm predicts the future location of a mobile user according to the user's previous movement patterns [3]. By combining the predictive mobility management algorithm with a mobility agent scheme, the management system can prepare service and data at the locations to which the user is moving. The main drawback of their algorithm is its high sensitivity to so called "random movements." Any movement that cannot be classified by the simple mobility patterns defined is classified as random movement. Prediction performance of their algorithm decreases linearly with the increase in the random factor.

Location update and paging

In this section, four location update and paging strategies,

A **Profile-Based Strategy** – This technique considers that the user location probability When the terminal moves from one location area (LA) to another, it checks if this new location area belongs to the profile. In the negative case, it performs the standard procedure otherwise it does nothing. In the case a call arrives to a terminal located in a LA included in the profile, the system will page the profile sequentially, according to the location area probabilities. If the terminal is outside its profile the reference procedure is adopted.[4]

B **Reducing Location Update Cost** - In this algorithm, both the terminal and the home location register (HLR) have a small memory where the last two visited location areas are stored. The HLR memory is updated only when the mobile moves to a LA distinct from the ones stored in the memory[11]. As shown in fig. 3 each location area has single cell. The HLR of each cell can store last two visited locations.[5]
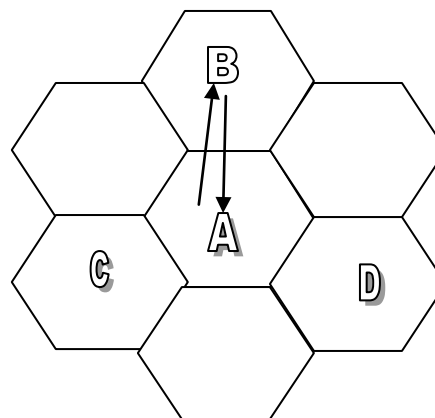

Fig. 4. Movement between two cells

C. A Caching strategy to Reduce Network Impact of PCS

This strategy proposes that a local storage (cache) be maintained in the MSC's (Mobile Switching Centers), to

store user's information. The user address is stored in the cache and updated each time a call to this user is initiated from the switch where the cache is located. The next time a call is originated, the system queries the cache. If the user is still located on the pointed location area, this is called "cache hit," contact with HLR is avoided [6]
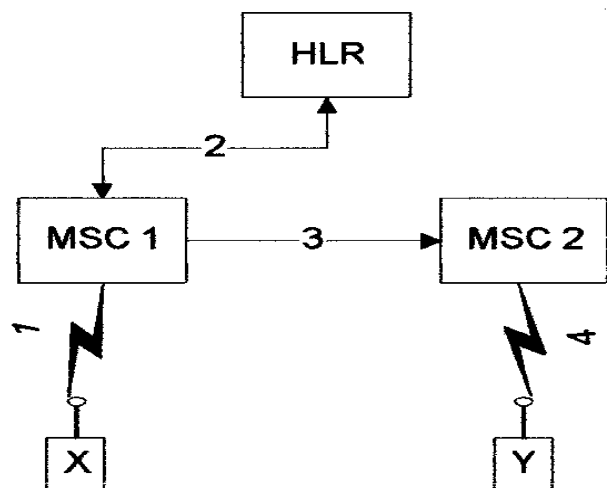

Fig. 5 signaling steps required to establish a call between user x and y

And the signalling costs are reduced. If the called user has already moved, a "location miss" happens and the reference procedure has then to be applied resulting in larger signalling costs. Illustrating the use of this strategy, Fig. 2 depicts a procedure on which user requests the establishment of a connection to user located in the coverage area of another switch. The serving MSC (MSC 1), queries the HLR about the location of user (transaction 2) and stores on its cache the address returned. With this address, MSC 1 requests MSC 2 (transaction 3) to page user (transaction 4). Next time a call is originated in MSC 1 to user the system uses the address in the cache. If the user is still located on the pointed LA, the signalling costs are reduced, otherwise the costs are increased.

D. A Dynamic Mobility Tracking policy

It basically consists in performing a LU each time the terminal verifies that the estimated cost of performing a paging become greater than the cost of updating the location register. When the terminal updates its location register, the cell on which it is presently located is labelled cell 0 and the cells surrounding this cell are arranged in

rings classified by indexes. The user location register is updated only when a LU is performed. When a call arrives to a terminal, the system pages the rings sequentially from the cell 0 to the others. [7]

5. CONCLUSION

In GSM system, mobile systems move from one cell to another. This leads to frequent change in their location. So it is necessary there should be proper location management techniques to deal with this situation. Location management concerned with the current position of mobile unit. Various methodologies for are proposed by various researchers for location management. In this paper we analyzed these techniques. Further based on study of these techniques we can proposed a new scheme by using existing parameters i.e. by introducing no payload or at the cost of zero extra bandwidth.

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