A Model for Solving Network Location Management Problems (Lmps) in a Dense Cell Environment

Toyin Enikuomehin
Dept. of computer Science,
Lagos State University
Lagos, Nigeria
Corresponding Email: toyin@lasunigeria.org

Abstract

Before the emergence of GSM technology in many developing societies, telecommunication has been made possible by the powers of discreet fixed telephony devices which use fixed leased lines. Users therefore are restrained to their location during a process of communication. Mobile networks were developed to resolve this bottleneck such that users can communicate irrespective of their location even in motion changing from one geographical location to the other. The user might not see the change but the network provider battles some problem in this process of change. In this paper, we present the state of the problems and a model to understand the management of the communications services in respect to change in physical geographic locational movement in every possible direction. This paper proposes a solution to emerging problems from this change in location during the process of communication.

***Keyword*s**: Mobile Networks, Cell, Geographic location Management, Directional Movement

1-INTRODUCTION

Mobile voice communication is widely established throughout the world and has had a very rapid increase in the number of subscribers to the various cellular networks over the last few years. An extension of this technology is the ability to send and receive data across these cellular networks. This is the principle of mobile computing. Mobile data communication has become a very important and rapidly evolving technology as it allows users to transmit data from remote locations to other remote or fixed locations. This proves to be the solution to the biggest problem of business people on the move - mobility. Mobile communication, past present and future (Stetzler, 2000). In this process, users can make voice or data services across boarder lines without an interruption in transmission of such services. For a network to exist, there must be the capability of connecting a device at an end to another device at another end, we can associate this as connection between two cellular devices. This is a minute part of the mobile cellular network. An ideal cellular network is made of the following: some mobile units, switches, linked such that an interconnection between network can exist and allows access to fixed Public Switched Telephone Network (PSTN). This process is not open to the user however they are embedded into special network transceivers. These transversal has the ability to carry large traffic as applicable and required in large cellular networks. They are known as Base Stations. A mobile phone sends and receives information (voice messages, fax, computer data, etc) by radio communication. This information is transmitted to the nearest base station, which receives and transmits radio signals in its area using the context of simplex communication. A Base Station (BS) is assigned to a particular geographic location or area. This area is called a Cell: (the reason why an area covered by a BS on network is called cellular network). Base stations are connected to one another by central switching centres, which track calls and transfer them as the caller moves from one cell to the next. Large geographical area covered by base stations is called a macro cells; and consequently, the small areas are microcells or picocells. Most urban location has marcrocells. The number of cells varies in different areas, depending on the volume of use. Areas with a high volume of mobile phone use will have more cells. As the phone user moves around, the radio signal can be switched from one cell to another, maintaining a good connection. Every BS is located at a strategically selected place and covers a given area or **cell** - hence the name cellular communications. A number of adjacent cells grouped together form an **area** and the corresponding BSs communicate through a so called Mobile Switching Centre (MSC). The MSC is the heart of a cellular radio system. It is responsible for **routing**, or **switching**, calls from the originator to the destinator. It can be thought of as managing the cell, being responsible for set-up, routing control and termination of the call, for management of inter-MSC hand over supplementary services, collecting charging and accounting information. The power level generated by a cellular phone to maintain a good connection depends on the distance from the base station; the greater the distance, the more power is needed. Cellular phones automatically step down to the lowest power level that maintains communication with the base station. Since there may be interference from neighbouring channels in the cell, or from physical obstacles, the amount of power needed may vary within a single telephone call.

Mobile communication/cellular communication is a technology that allows the use of radio frequencies for the connectivity of large number of users over a several network. A process of handshake also exists between devices.

2- The problem of Geographic presence in Telecommunication

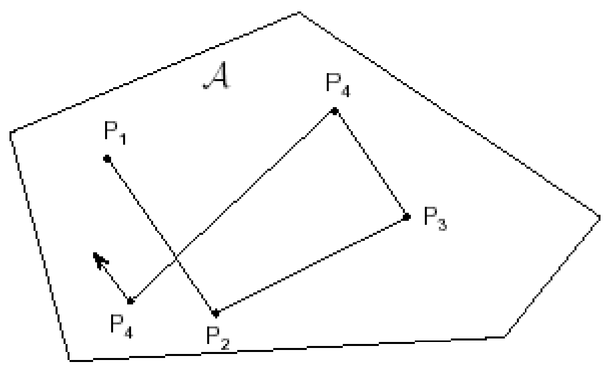
IT and Telecommunication has changed the way we live. Every sector of the any economy takes part in this. A principal aspect of it is that of mobile communication which has now been accepted as part of office procedure. This has led to more venerability in general security vis a vis the security of persons, live and even assets. The need for a more effective geographical location management cannot be over emphasized as users has the flexibility to commit crime from a location and move virtually to other location and still enjoy a flawless cellular communication. A common issue commonly agreed to by vendors is that of high traffic which has been attributed to calls connection delays and increment in the number of uncompleted and drop calls. Problems exist with the process of updating and searching the current locations of multiple mobile nodes in a wireless network. This is the general LM problem. The purpose of this paper is to generate an appropriate model to solve the LM problems and reduce management cost. So many authors have contributed to the problem of LM, we review a few of them and categorize them by their model type and present an overview of the existing work. Some models already referenced in literature includes Brownian model, random waypoint model, random walk model ,random direction model, random Gauss-Markov model, Markovian model, incremental model, mobility vector model, reference point group model (RPGM), pursue model, nomadic community model, column model, fluid flow model exponential correlated random model, map based model (Tabanne, 1995). However, we shall limit are observations to the scope of this paper.

2-LM Models and Applications

2-1-1- Random Waypoint Model

Random Waypoint (RWP) model is a commonly used synthetic model for mobility, e.g., in Ad Hoc networks. It is an elementary model which describes the movement pattern of independent nodes by simple terms. In a RWP, each node moves along a zigzag line from one waypoint to the next, the waypoints are uniformly distributed over the given convex area, e.g. unit disk. At the start of each leg a random velocity is drawn from the velocity distribution in the basic case the velocity is constant (Neskovic, 2000). Optionally, the nodes may have so-called "thinking times" when they reach each waypoint before continuing on the next leg, where durations are independent and identically distributed random variables. The Random waypoint

model, first proposed by Johnson (Johnson, 1996), soon became a "benchmark" mobility model to evaluate the Mobile ad hoc network (MANET) routing protocols, because of its simplicity and wide availability.
Two variants, the **Random walk model** and the **Random direction model** are variants of the Random waypoint model



the mean time a node spends on a single leg is proportional to 1/E[1/V].

2-1-2 Mobility pattern:

The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time. Since mobility patterns may play a significant role in determining the protocol performance, it is desirable for mobility models to emulate the movement pattern of targeted real life applications in a reasonable way. Otherwise, the observations made and the conclusions drawn from the simulation studies may be misleading. Thus, when evaluating MANET protocols, it is necessary to choose the proper underlying mobility model. For example, the nodes in Random Waypoint model behave quite differently as compared to nodes moving in groups (Frost and Melamed 1994). In the many studies on mobility patterns in wireless cellular networks (Ramanathan, S., and Steenstrup M.,1996), researchers mainly focus on the movement of users relative to a particular area (i.e., a cell) at a macroscopic level, such as cell change rate, handover traffic and blocking probability. There is a need to know the next location of a user for effective management, that is, the user movement pattern; a mobility model must be designed for this purpose. The random work is still the known simplest model out of all proposed models. The idea is that it is assumed that the movement of users are entirely random and the best prediction is by employing some random modelling tools. Fluid Flow uses a scheme that network are whole and treated as an entity. In fluid flow, networks are aggregated in the movement pattern of the users. This is used to denote the specific location of the node at any given time. This method is problematic in implementation when it comes to consideration of micro cells. This macroscopic model forms an aggregated movement model for the network. It is generalized that the travelling pattern of the user can be placed in the direction (0, 2pi); this implies a proportionality of traffic and population density that can be represented as
Navg = rho(pi)Dv where

The **pursue mobility model** is a type of mobility model which is used in ad hoc wireless networks. It is also based on RPGM (Reference Point Group Model). The Pursue Mobility Model simulates scenarios where several nodes attempt to capture single mobile node ahead. This mobility model could be used in target

tracking and law enforcement. The node being pursued (i.e., target node) moves freely according to the Random Waypoint model. By directing the velocity towards the position of the targeted node, the pursuer nodes (i.e., seeker nodes) try to intercept the target node.
The Pursue Mobility Model consists of a single update equation for the new position of each Moving Node: new position = old position + acceleration(target—old position) + random vector.
Example: Nodes chase after a single target that may or may not be moving. Here we have a collection of robots (nodes) trying to catch a single robot that acts as a target. This kind of behavior is found in multiple robotics activities (e.g.: people tracking and so on).
The Markov mobility models is one of the most used model due to its high level of accuracy, it uses the theory of back propagation where next movement is determined by the understanding of many previous movements. At large computational cost, every inter-cell movement probability is defined for each user. An extension of the Markovian model, created at perhaps even greater cost, is the activity-based model. In this model, parameters such as time of day, current location, and predicted destination are also stored and evaluated to create movement probabilities. An even more complex activity-based scheme might provide better results, but would not be implementable on a large scale due to its immense costs (Cowling, 2004). Cowling suggests that an appropriate LM will be achieved if base stations could determine mobility characteristics and patterns. This learning network provides the basis of a Markov model, with the full knowledge of movement probabilities and theoretically incurring low overhead.
A **traffic generation model** is a stochastic model of the traffic flows or data sources in a communication network, for example a cellular network or a computer network. A **packet generation model** is a traffic generation model of the packet flows or data sources in a packet-switched network. For example, a web traffic model is a model of the data that is sent or received by a user's web-browser. A passion flow is generated form this model. The process is used for small coverage area. Recall that the passion law exist for small numbers.

The Random Waypoint model and its variants are designed to mimic the movement of mobile nodes in a simplified way. Because of its simplicity of implementation and analysis, they are widely accepted. However, they may not adequately capture certain mobility characteristics of some realistic scenarios, including temporal dependency, spatial dependency and geographic restriction.
The RWP allows for free measure of movement between nodes within a defined simulated geographical region. This act is peculiar to other random models. This asupmtion has been open to many queries as it does not represent the entirety of normal human situation where we expect that in some cases, movement may be bounded by barriers such as houses, trees etc which are also items that adds to the determination of through puts within a defined geographic area especially in urban settings.
Clearly from above, the Random Waypoint model and other random model do not satisfactorily represent the true user mobility system as apparent in mobile network. Upamanyu and others (Upamanyu M., Mchael Honig L., and Kenneth S., 1995), gives detailed analysis of movement pattern and traffic system as regard mobility tracking. Empirical data gathered in these experiments reveals that the 10% most mobile users account for approximately two-thirds of the total number of calls within the network. Consequently, such users must be given appropriate consideration involving resource allocation. Over half of users appeared to be stationery, and most (but not all) such users generated much less cellular activity. Therefore, only a weak correlation between user mobility and data traffic exists. This further adds to the need to develop a more functional model with better correlation.

3- GAUSS-MARKOV MOBILITY MODEL

We adopt the GMM Model as applicable in (Liang B. and Haas J., 2003). A Gauss-Markov linear model is a linear statistical model that satisfies all the conditions of a general linear model except the normality of the error terms. Formally, if **Y** is an m -dimensional response variable vector, and **Zi**=zi(**X**) , i=1,...,k are the m -dimensional functions of the explanatory variable vector **X** , a Gauss-Markov linear model has the form:

$\mathbf{Y}=\beta_0\mathbf{Z_0}+...+\beta_k\mathbf{Z_k}+\epsilon$, ... (1)

with ϵ the error vector such that

(i) $E[\epsilon]=\mathbf{0}$, and

(ii) $Var[\epsilon]=\sigma^2\mathbf{I}$.

In other words, the observed responses Yi , i=1,...,m are not assumed to be normally distributed, are not correlated with one another and have a common variance$Var[Y_i]=\sigma^2$.

Theorem

Gauss-Markov Theorem. Suppose the response variable **Y**= $(Y_1,...,Y_m)$ and the explanatory variables **X** satisfy a Gauss-Markov linear model as described above. Consider any linear combination of the responses

$Y=\sum_{i=1}^{m} c_iY_i$, ... (2)

where $c_i\in\mathbb{R}$. If each μ_i is an estimator for response Yi , parameter θ of the form

$\theta=\sum_{i=1}^{m} c_i\mu_i$, ... (3)

can be used as an estimator for Y . Then, among all unbiased estimators for Y having form (2), the ordinary least square estimator (OLS)

$\hat{\theta}=\sum_{i=1}^{m} c_i\hat{\mu}_i$, ... (4)

yields the smallest variance. In other words, the OLS estimator is the uniformly minimum variance unbiased estimator. $\hat{\theta}$ in equation (3) above is more popularly known as the BLUE, or the best linear unbiased estimator for a linear combination of the responses in a Gauss-Markov linear model. Liangt and Haas (Liang B. and Haas J., 2003) introduced the use of Gauss Markov for mobility prediction. It has since been considered as an appropriate model for use for understanding the patterns of users' improvement. This model is thus improved upon in our own perception.

3- The Proposed Mobility pattern prediction Model

Since this research is majorly for updating as a user changes from one cell to the other, we apply the model over a continuous time. We note that such movement of the user can be random thus a way to predict this is by the use of the random continuous model. Predicting the mobility pattern of a mobile user is a great factor in determining the next cell resources for mobile services. This is a method we assume will assist in the quick convergence of the cost analyzer when changing between cells. The purpose of such prediction pattern is to have many report temporarily allocated to the next resource user such that as we the moves to another cell, the closest resource that matches the user's parameter is assigned. A cellular mobile user in k has three options, may stay in k, move to k+1 or move to k-1. We attempt to model this system of the user mobility by assuming that each movement is dependent at a time t which can also not be predicted however the presence at a point /cell is associated with a time t before the change in position.

To model the movement of the mobile users in the system, we assume that time is slotted, and that a user can make at most one move during a slot. The movements will be assumed to be stochastic and independent from one user to another. Updates can be implemented with any of the following consideration

Time, Movement and Distance Markovian are implemented with such models. For any user, three possible states are possible, a stationary position, movement to right, or movement to left.
In the Markovian model, during each slot, a user can be in one of the following three states:

1. The stationary state A,
2. The right-move state B, or
3. The left-move state C.

However earlier consideration did not include backward, D and forward movement, E. We wish to include this possibility in this paper. It means that the randomness can be seen as a circled possibility. The problems can be associated with arrays with connected end points.

Consider a user in a particular cell, say k, at the time a call is made or received, location update will be required if change from k exist. If it exist, 5 possible movement shall be considered, if the user did not change a position, we associate it to A, that is, the user remains in the stationary position throughout the duration of the call. If the user changes position from A to B, we say it moves to the cell k+1, and if the user is in state B then it moves to cell k – 1. We also consider movement forward as k+c+1 and movement backward as k-c+1.

Let us denote Y(t) as a state for any slot t. Assume that {Y(t); t = 0; 1; 2;...} is a Markov chain with a transition probabilities pi,
X = Prob[Y(t + 1) = X = Y(t) = i] as follows:
pB, B = pC, C = q, pC, B = pB, B = v, pA, B = pA, C = p, pC, pD, D = pE, pE, E = pA, A = pB, A = 1 – q – v and pA, A = 1 – 2p
such that for every movement M, each user is expected to transit an update at any time t. In time-based update, each user transmits an update message every T slots, while in movement-based update, each mobile user transmits an update message whenever it completes M movements between cells, and finally in distance based update, each user transmits an update message whenever the distance, in terms of cells, between its current cell and the cell in which it last reported is D. The process of sending update is called reporting.

For any slotted time t, let X(t) denote distance between the cell for any user and the cell in which the user last transmitted an update message. As before, positive (negative), constant positive (negative) , X(t) indicates that the user is to the right (left), forward(backward) of the cell that made the last update transmission. Clearly, the interval is $-(M-1) \leq Y(t) \leq M-1$.
Let $L(t) = \max\{\pi \leq t |$ The user reported in slot $\pi\}$. Let I(t) be the probabilities can be computed recursively from the above relations. Using transform techniques, one may obtain expressions for these probabilities. We observe that matlab is best used in the simulation of the code for the random walk model where various variables are being declared:
N – as the number of trials
k – as the number of walks
d – as the dimension
s – as the step size.

4- CONCLUSION

We have investigated the process involved in general mobility theory. We further propose an extension of the three way update strategy to include the backward and forward movements as applicable in real life. A model has also been proposed for this extension. The gauss markov process shall be extended from the stochastic format to a continuous baseline. This extension only helps to resolve the current challenges of network location updates.

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