Simulated Annealing For Mobile Location Management: A Practical Approach

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ABSTRACT

Simulated annealing is a computer algorithm widely used to solve the mobile location management problems through extended simulated computing system. It is frequently used to place circuit in non-overlapping location on a VLSI chip. Simulated annealing consumes substantial amounts of computation. The main reason is to use simulated annealing to search for feasible solutions and then converge to an optimal solution. Simulated annealing takes these constraints into consideration, load and capacity information. The proposed simulated was simulated using Java code. The algorithm was developed and written on Netbeans 1.6 platform. The information from the proposed simulated annealing in relation to time of cost was 5.5132 with a time cost of 3.2 seconds, compare to non-update of 20.7896 at a time cost of 4.56 and always update of 4.6289 at a time cost of 1.5. Useful information for planning of the cellular network for tracking mobile user, search operation and cost of mobile terminal can be updated. Simulated annealing give optimal results in acceptable run-time.

Keywords: Simulated Annealing, Location Update, Mobile Location Management, Mobile Station, Mobile Station Controller, Reporting Cell.

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1. INTRODUCTION

Everybody wants mobility and because of that the wireless concept is growing up and up and wireless network is challenging day by day. The first and secondary generation wireless networks, such as analogue cellular, global system for mobile communication and personal communication systems have been widely deployed in the last decade or so. Cellular networks are a type of networks that support wireless connection to mobile station (MS). A cellular network is rapidly growing of mobile users and such growth increases signaling. Signaling requires too much bandwidth for all operations, while Radio Bandwidth is of limited resources. To decrease signally operations it is required to do better Mobile Network planning. Simulated annealing is a computer algorithm widely used to solve difficult optimization problems. Simulated annealing consumes substantial amounts of computation. In response, researches have parallelized annealing in many different ways with mixed results. The first widely available publication on simulated annealing by Kirkpatrick provides a brief practical overview. Van Learhoven and also provides a more complete introductory treatment of simulated annealing. The simulated annealing algorithm was derived by modifying the greedy algorithm showing how circuit placers used simulated annealing and describe the relationship between thermo dynamics and simulated annealing.

1.2 Statement of the Problem

The idea is to use simulated annealing to search for feasible solutions that does not allow infeasible solutions but will sometimes need to explore infeasible area of the search space to allow us to find a good solution. We all know that a location management cost is depended on the location area. So, location area planning can be done by simulated annealing. In this research, GSM network is used as a cellular network model. If we want location area planning in GSM network, it is necessary to satisfy all constraints required for reducing the total location management cost and from that we are able to get better GSM network. For location area planning, simulated annealing takes these two constraints into consideration, Load and Capacity information, as an input and finds an optimal or near optimal solution as a network topology which includes the assignment of base stations on location areas.

1.2 Objective

The aim of these studies is to analyze the performance of simulated annealing for mobile location management and achieved the objectives highlighted below;

(a) To investigate the design of issues on location management cost in GSM network.
(b) To design and develop a location planning area in cellular network.
(c) To simulate the balance between the LA update rate and expected paying rate within LA.
(d) To evaluate and compare the cost estimate of location area in cellular network.

2. LITERATURE REVIEW

Simulated annealing (SA) is random-search technique which exploits an analogy between the way in which a metal cools and freezes into a minimum energy crystalline structure (the annealing process) and the search for a minimum in a more general system; it forms the basis of an optimization technique for combination and other problems. In 1983, SA was developed for dealing with highly non linear problems. An important characteristic of the SA algorithm is that it does not require specialists' knowledge about how to solve a particular problem. This makes the algorithm generic in the sense that it can be used in a variety of optimization problems without change the basic structure of the computation.

In neighboring solution, collection of all the optimal and non-optimal solutions is called space. During annealing process, algorithm randomly selects any solution from these solutions space. We know that the location management cost is depended on the LA. So LA planning plays important role in cellular network. LA planning can be done by SA. In this paper, GSM network is used as cellular network model. If we want LA planning in GSM network it is necessary to stratify all constraints required for reducing the total location management cost and from that we are able to get better GSM network.

2.1 Simulated Annealing For LA Planning

For LA planning, SA takes these constraints into consideration, load and capacity information as an input and finds an optimal or near optimal solution as a network topology which include the assignment of BSs to LAs.

2.2 Complexity of LA Planning Problem (Solution Space)

The solution space consists of both feasible and unfeasible solutions. Here, solution space consists of all possible network topologies, the BS-to-BSC, BSC-to-MSC and BS-to-LA assignments determine the complexity of the solution. SA feasible solution to a topology, where all network nodes (BSs, BSCs, and MSCs) are connected and LA borders are satisfied. Therefore, a (feasible) neighbor solution may be generated using the following move;

1. Changing a BS-to-BSC assignment – before executing this move, the capacity constraints affected by this BS-to-BSC connection are checked. If these constraints are not violated, the new BC is assigned to the BS.
2. A random feasible LA is searched to assign that BS among the existing Las residing in the new BSC. Because of this limitation that LA cannot spread over multiple MSCs. If no feasible LA is formed, then a new LA is created for the new BSC. Next, all load updates resulting from that move are calculated on the network.

2.3 Implementation of Simulated Annealing For LA Planning

The entire variables related to GSM network are used in implementation of LA planning using SA. To make this experiment dynamic and reusable all the variables are taken in text file format.
Here, SA is used to satisfy GSM constraints to obtain better cellular network.

2.4 Size and Shape of LA

Size and shape of LA is important in cellular network. The size of an LA or the number of cells in it may vary depending on the rate at which cell receives calls and on the inter-cell traffic characteristics and the number of user. In fact, the size of an LA can be optimized to create a balance between the LA update rate and the expected paging rate within an LA.

In other words, proper planning of LA reduces total location management cost. There are two extreme LA planning approaches;

- The services area equal an LA: here LUs are not required which generated due to mobile movement in service area while paging cost is increased because whenever an MS is called, it is paged over the whole service area.
- In this case, paging signaling load can be enormous especially during busy hour. The cell area equals an LA: in this case, the location of an MS is determined with accuracy of a single cell area. The need for paging here is minimal, paging does not locate the MS, and it just alerts the terminal for the incoming call.

However the number of LUs is expected to be enormous due to the small call size and the user mobility.

3. METHODOLOGY

Simulated annealing takes care of greedy algorithm with a random escape from the local minima. The cost of a location management in mobile location management, a cost component is being attached to each location update performed as well as to each paging of cell. Wireless bandwidth is the most common cost components that are used. That is, the wireless traffic from mobile terminals to based stations during location updates paging.

The formula below is used to calculate the total cost of a location management.

Total cost = C * NLU + NP

Where; NLU – number of location updates performed during time T.
NP – number of paging performed during time T.
C – is a constant representing the cost ration of location update and paging.

The research shows that the cost of location update is usually much higher than the cost of paging.

The wireless network consists of cells. These cells are usually represented in hexagonal cells as shown below;

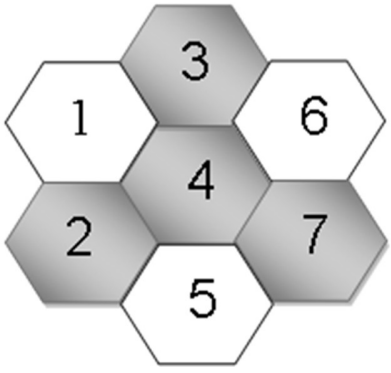


Fig. 1: The figure above shows cells network with reporting cells

However, for a simple cellular system, there is no base station per cell and a large number of base stations in the system. In this approach, a subset of base called reporting center is selected among all base stations. The cells associated with these base stations are referred to as reporting cells. We have two types of cell network configurations; the reporting cells and non-reporting cells. However, for mobile location management cost evaluation purposes, the maximum vicinity value will be used. In RC planning, with each cell i, a movement weight, and call arrival weight, denoted wmi and wci, respectively are associated. The movement weight represents the frequency or total number of movement into a cell, while the call arrival weight represent the frequency or total number of call arrivals within a cell.

Formulas for the total number of location updates and paging (performance during a time period T) are given as follows:

$$NLU = \sum_{i \pounds S} Wmi$$

$$Np = \sum_{J=0} Wcj.\ V(j)$$

Where wmi denotes the movement weight associated with cell i, wcj denotes the total number of cells in the network, and S denotes the set of reporting cells in the network.
Using equation (1) and (2), the formula to calculate the location management cost of a particular reporting cells configuration is given as follows;

$$\text{Total cost} = C^* = \sum_{i \pounds S} Wmi + \sum_{J=0} Wcj.\ V(j)$$

4. RESULT AND DISCUSSION

The thesis was developed using the simulation to investigate the annealing search that provide the location management. Some java script was writing to model the cellular network. Initial the reporting cell information of the cells that was considered was constructed.

4.1 Planning of the Cell Network

The test network used in this work was an extension of 19 cell network. The study constructed the 19 cell planning by reporting the order of effectiveness for the simulated annealing approach.

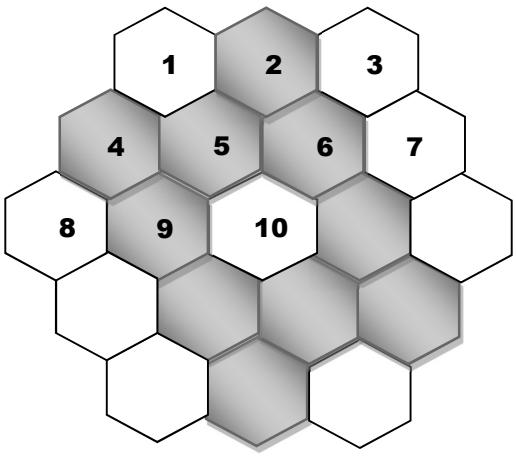


Fig. 2: Cell configuration for cellular network

The 19 – cell network was simulated and the results of extended simulated annealing for mobile location management were analyzed as a date set in fig. 4.3 below. The average calculated value for the best reporting cell configuration was 27 with initial temperature. The cost comparison for 19 cell network shown that the simulated annealing algorithm obtained better solutions.

4.2 Simulated Result of the Data Set of Location-Update

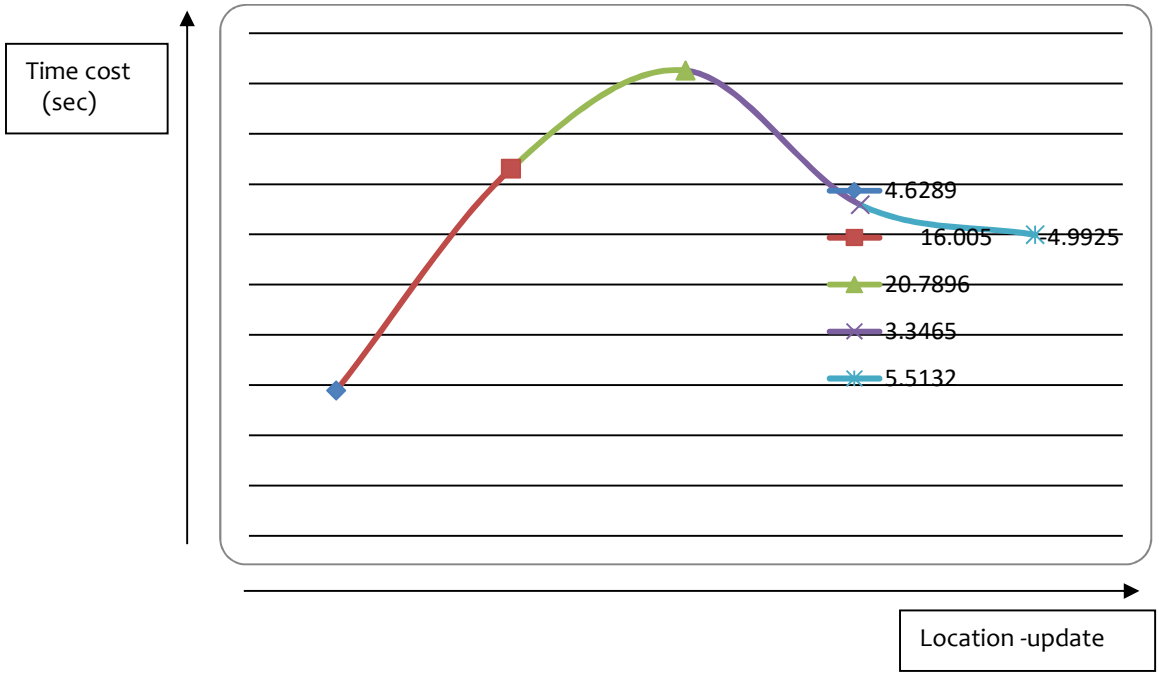
TABLE 4.3

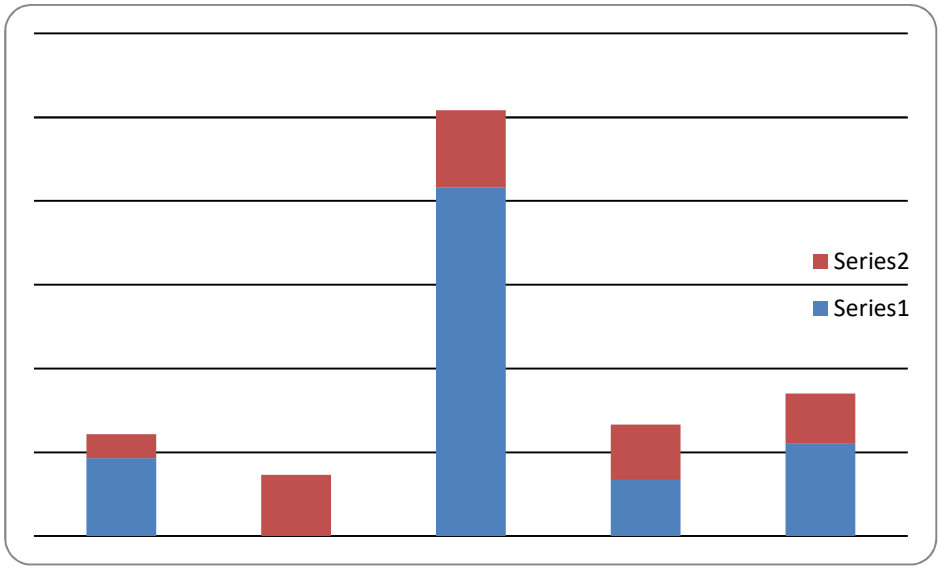
Cell	1	2	3	4	5	6	7	8
W_{mi}	96	27	134	7	46	43	64	32
W_{ci}	27	20	2	1	4	4	15	8

Cell	9	10	11	12	13	14	15	16	17	18	19
W_{mi}	40	239	28	271	144	12	66	42	88	28	96
W_{ci}	1	55	6	2	27	16	29	71	22	59	14

4.3 Result of Simulation Average Data Set

The graph in fig. 4.4 below shows the average data set during the simulation process at 20.7896 location up-date was at the peak with a time cost of 4.5bsec. The useful information denoted that the service coverage is at peak which can result in zero update cost. Considered the proposed simulated annealing, the information here shown that location up-date can be managed at a minimal time cost of 3.2bsecs at 5.5132m. This data set from the proposed simulated annealing can be useful during the planning of cell networks.





From the above figureabove, comparisons of cost for the cells network, it can be seen that the simulated annealing algorithm obtained better solutions.

Table 2: Result For The Time Cost Location Up-Date

		TIME COST (SECS)
Always-updated	4.6289	1.5
None-updated	20.7896	4.56
Proposed SA	5.5132	3.2

The information from the above table 2 present the time cost and the location update during the simulation process. The proposed simulated annealing was used to compare the always-up date location and none updates location. The location-update for the proposed simulated annealing was at 5.5132m at a time cost of 3.2 secs and for non-update location was at 20.7896 with 4.46 time cost. The proposed simulated annealing denote that there are sufficient number of random moves can visit different cells location at a minimal cost. This result will provide good planning during deployment.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

In this analysis, a new approach based on the simulated annealing technique is presented to solve the mobile location management through extended simulated computing system. In mobile location management, some cells in the network are designated as reporting cell. A mobile terminal will update its location when it enters a new reporting cell. The goal of mobile location management cost is minimized. Mobile location management problem is a difficult combinatorial optimization problem.

5.2 Conclusion

A simulated annealing meta-heuristic is used to obtain near to optimal solution for a mobile location management problem. Simulation result are presented for test networks with 19 and 36 cells. Simulation result shows that simulated annealing algorithm can be effectively used to obtain near to optimal result for mobile location management problem, it produces better results than two classical location management strategies – always-update and never-update and also produce results competitive with results obtained by other authors.

5.2 Recommendation

The techniques in this discuss in this thesis should be extended across a wider range of vulnerabilities and tested against more network configuration cells.

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