Asian Journal of Computer Science and Technology
ISSN 2249-0701 Vol. 4 No. 1, 2015, pp.1-7

Pervasive Location Management Using Genetic Algorithm

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Abstract - **In mobile environment, mobility plays an important role i.e. without mobility there won't be any transaction in mobile networks. A mobile user calls stir from anywhere on the network. To keep the mobile connected, the networks should keep track of the incoming mobile receptive system. Both network should be effective, efficient to identify the optimum path and faster to find the number of mobile users. This is called location management, which contains the above two things in an efficient and effective manner. Here location update means the process of tracking the mobile terminals and paging means to find the correct mobile terminals. The main aim of this paper is to compute the least location update cost in pervasive environment. Actually this paper is used to integrate the intelligence in mobile environment to identify the least location updation and paging cost. By use of this intelligence, the extraction of output and its level of accuracy are very high. Here intelligence is used to manage the location. Here we have proposed to implement the above two aspects by using various operators of genetic algorithm to solve the reporting cells planning problem because the solution space to be searched is huge and its popularity & robustness. And also the new version of mobility pattern is used to minimize the total cost and to balance the Location update and search Paging. In the new system one mobility pattern is maintained in each and every visited cell. If the number of pattern is increased then the movement weight is reduced and the updating cost and seeking cost is also reduced. Mobile terminals update their positions upon entering one of these reporting cells.**

In our previous paper, we have used network size of 4X4 for testing purpose and in conclusion, we have mentioned the 6X6 and 8X8 network size as future extension. In this paper we have implemented that extension work for number of generation are 500 and 1,000 for executing various existing algorithms like POFLA, UMP and MIPN. Comparatively the new system is better than any other existing system we have mentioned. The main drawback here is same time taken for first call and maintain less time for subsequent calls only.

Keywords: **Location Updates, Location Paging, Mobility Pattern, Call To Mobility, Cells, Vicinity, Reporting Cell**

I.INTRODUCTION

In Pointer forwarding based Location Area (POFLA) [1], a mobile terminal performs location update to the Home location register (HLR) every time the user crosses a Registration Area (RA) boundary, and deregisters at the previous visitors location register (VLR). If many users are far away from their HLRs, heavy network traffic occurs. The local anchor scheme reduces the drawback by choosing a local anchor for each user. Whenever the user moves from one RA to another, the mobile terminal will perform location update to the local anchor. The drawback of this method is that when the user keeps moving constantly without receiving any call, the updates to local anchor may become costly too.

In user profile based Location Area method(UPBLA) [2], a profile was constructed to store the user's daily routine information. If the user follows the profile well, the traffic update rate is reduced. When a call arrives to a user the paging can be implemented in all the Registration Area (RA) at the same time, the location update cost is reduced. If there is any deviation from the routine, the mobile terminal is required to report to the new VLR every time.

In the User Mobility Pattern (UMP)[4] a pattern is considered and retrieved for location update and call delivery procedures. Here the traffic and the paging delay is also less. This system can predict a user's future location well in advance if the user wants to engage in some important applications. This can improve the QoS greatly.

In the Mobile IP Network (MIPN) [5], mobile terminals that can change their locations in different subnets are called Mobile Hosts (MHs). An MH has a permanent address registered in its home network and this IP address remains unchanged and can be used for identification and routing, which is stored in a Home Agent (HA). A HA is a router in a mobile node's home network, which can intercept and tunnel the packets for the mobile node and also maintains the current location information for the mobile node. Mobile IP is not a good solution for users with high mobility. Here the location update cost can be excessive with relatively high mobility and long distance from their HAs.

The Call-to-mobility ratio (CMR) [6] is the ratio of the number of calls for locating a mobile client over the number of cell boundary crossing. If CMR is less, i.e., not many location calls to a mobile client per cell boundary crossing, the generation of a location update from a mobile client will not result in much saving in the cost for locating the mobile client. So generation of a location update should be deferred for this case, if CMR is large, i.e., there are a large number of calls to a mobile client per cell boundary crossing, the generation of a location update can reduce the location cost significantly.

A.Location Management Cost (LMC)

LMC [3,7]involves two elementary operations of *location update* and *location inquiry*. Clearly a good location update strategy could reduce the overhead for location inquiry.

$$Total management\ cost = C.N_{LU} + N_P$$

Where N_{LU} - the no of location updates; N_P - the no of paging performed; C - constant

The network consists of hexagonal cells [2,3,6]resulting in six possible neighbors for each cell. Here some cells are designated as reporting cells. Mobile terminals perform a location update upon entering one of these reporting cells. When calls arrive for a user, the user has to be located. Some cells in the network may not need to be searched at all, if there is no path from the last location of the user to that cell without entering a new reporting cell.

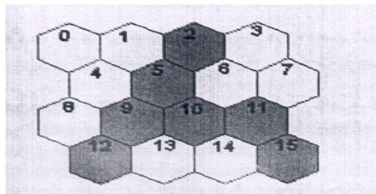

Fig.1 Network with reporting cells

In the above figure, a user moving from cell 4 to cell 6 would have to enter a reporting cell. For location cost evaluation, the cells that are in bounded areas are first identified and the maximum area to be searched for each cell is calculated. Here the vicinity of reporting cell is the collection of all the cells that are reachable from a reporting cell without entering another reporting cell as the vicinity of reporting cell. And the vicinity value of reporting cell is the maximum number of cells to be searched when a call arrives for a user whose last location is known to be cell i.

B. Procedure for Finding Vicinity

(1) Of a Reporting cell

a. Start from a reporting cell to find the valid neighbors of the reporting cell
b. If the valid neighbor is not a reporting cell and not yet visited then mark it as I.
c. Add the neighbor to the Vicinity Index of the reporting cell.
d. Increment the vicinity number of the reporting cell by one.
e. Make a recursive call to the same function for all valid neighbor cells.
f. End function – If the neighbor is a Reporting cell or a visited cell then the function returns zero.

(2) Of a Non Reporting cell

a. Take non-reporting cell and find the reporting cells from which this cell can be reached (OR) take non-reporting cell and find the Reporting cells to which it is the vicinity member.
b. Find the maximum vicinity value among the Identified Reporting cell.
c. Assign that value as the vicinity value of the Non Reporting cell.

In the above fig1, the vicinity of reporting cell 9 includes the cells 0,1,4,8,13,14 and cell 9 itself and the vicinity value is 7. Each non reporting cell can also be assigned a vicinity value. However, it is clear that a non-reporting cell may belong to the vicinity of several reporting cells, which may have different vicinity values. For example, in Fig 1, a cell 4 belongs to the vicinity of reporting cells 2 5,9 and 12, with vicinity values 8,8,7 and 7 respectively. For Location cost evaluation, the maximum vicinity value will be used. As such, in this case, the vicinity value of 8 is assigned to cell 4.

Each cell i is associated with a movement weight (W_{mi}) and call arrival weight (W_{ci}). If a cell i is a reporting cell, the number of location updates could be dependent on the movement weight of that cell. Further the total number of paging performed would be directly related to the call arrival weight of the cells.

$$N_{LU} = \sum_{i \in s} W_{mi} \;; \qquad N_P = \sum_{j=0}^{N-1} W_{cj} * V(j)$$

Where N_{LU} - the no of location updates; N_P - the no of paging performed;
W_{mi} - the movement wt for cell i;
W_{cj} - the call arrival weight for cell j,

v(j) - the vicinity value of cell j;
N - the total no of cells in the network, and
S - the set of reporting cells in the network.
To calculate the location management cost of a particular reporting cells configuration (without history)

$$Total\cos t = C * W_{mi} + W_{cj} * V(j)$$

II.HISTORY BASED SYSTEM

Here we have maintained a history or mobility pattern of the last visited reporting cell. The updating does not take place when the user roams within the reporting cells. The location information is updated when the user enters to a new reporting cell, which is not in the pattern. When the number of reporting cells in the history is increased, the location update cost is also reduced. The cost equation can be modified as follows

$$N_{LU} = \sum_{i \in s} NW_{mi}$$ \\ NW_{mi} - the new movement weight.

$$NW_{mi} = W_{mi} * \frac{(S-h)}{(S-1)}$$ \\ h - the no of reporting cells \\maintained in the history

Here if we keep h=1, the $NW_{mi} \rightarrow W_{mi}$. By increasing the h value the NW_{mi} will be reduced, as a result the updating cost is reduced and the paging cost gets increased proportionately to the h value.

a. Whenever the user enters into the reporting cells, the mobility pattern is modified and does not lead to the location update.

b. Whenever a call arrives to the user, the user may be available within the vicinity of any one of the reporting cells in the pattern, which increases the number of cells to be searched. But it is only for the first time call. The next call to the user doesn't take much number of searches.

The *new paging* cost is obtained from the new call arrival wt. $NW_{cj} = W_{cj} * \left[\frac{NW_{mi}}{W_{mi}} \right]$

Search Cost for the Location updated users: $N_{Pi} = \sum_{j=0}^{N-1} (NW_{cj}) * V(j)$

Search Cost for the non-updated users from the same reporting cell: $N_{P2} = \sum_{j=0}^{N-1} (W_{cj} - NW_{cj}) * V(j) * \frac{1}{s}$

Search Cost for non-updated users from different reporting cell: (first call)

$$N_{P3} = \sum_{j=0}^{N-1} \frac{(W_{cj} - NW_{cj}) * (S-1) / S * V(j) * h / 2}{CallFactor}$$

For Subsequent calls $N_{P4} = \sum_{j=0}^{N-1} (W_{cj} - NW_{cj}) * (S-1) / S * (1 - 1 / callfactor) * V(j)$

The call factor
if (W_{cj}/ W_{mi})< 1 then call factor =1
else call factor = (W_{cj}/ W_{mi}).

Total Paging Cost : $N_{P'} = N_{P1} + N_{P2} + N_{P3} + N_{P4}$

$$Total\cos t = C.N_{LU} + N_{P'}$$

III. GENETIC ALGORITHM – FOR OPTIMIZATION

This algorithm is useful where the solution space to be searched is huge. It is a type of guided random search technique, able to find *efficient* solutions in a variety of cases. It contains three operators, namely selection, crossover and mutation.

A. Selection

It is used to emphasize the good solutions and eliminate the bad solutions in a population. A fitness value can be assigned to evaluate the solutions and quantifies the optimality of a solution. The value is used to rank a particular solution against all other solutions. A fitness value is assigned to each solution depending on how close to the optimal solution of the problem.

Assigning a fitness value:
Minimize $f(d,h) = c((\Pi d^2/2)+\Pi dh)$;
Subject to $g1(d,h) \equiv (\Pi d^2 h/4) \geq 300$
Variable bounds $d_{min} \leq d \leq d_{max}$ & $h_{min} \leq h \leq h_{max}$ here $c = 0.0654$

Various techniques to selection are Tournament selection, Roulette wheel selection, Proportionate selection and Rank selection.

In tournament selection several tournaments are played among a few individuals. The individuals are chosen at random from the population. The winner of each tournament is selected for next generation. Selection pressure can be adjusted by changing the tournament size. Weak individuals have a smaller chance to be selected if tournament size is large.

In Roulette wheel and proportionate selection, parents are selected according to their fitness values. The better quality of parents have more chances to be selected.

In rank selection a few good chromosomes are used for creating new children in all iterations, and some bad chromosomes are removed and the new children are replaced in their places. The rest of population migrates to the next generation.

B. Cross over

It is used to create new solutions from the existing solutions in the reproducing pool after applying selection operator. It exchanges the gene information between the solutions in there producing pool. The most popular crossover selects any two solutions randomly from the reproducing pool and some portion is exchanged between the strings.

C. Mutation

It is the introduction of new features in to the solution strings of the population pool to maintain diversity in the population. Mutation operator changes a 1 to 0 or vice versa. Here the probability is kept low for steady convergence. A high value would search here and there. A mutation is defined as successful if the mutated offspring is better than the parent solution.

```
Genetic_algm ()
{
Randomly initialize population (t);
Determine fitness of population (t);
Repeat
Select parents from population (t)
Perform crossover on parents creating population (t+1);
Performmutation of population (t+1);
Determine fitness of population (t+1);
Until best individual is GOOD enough
}
```

IV.PERFORMANCE EVALUATIONS

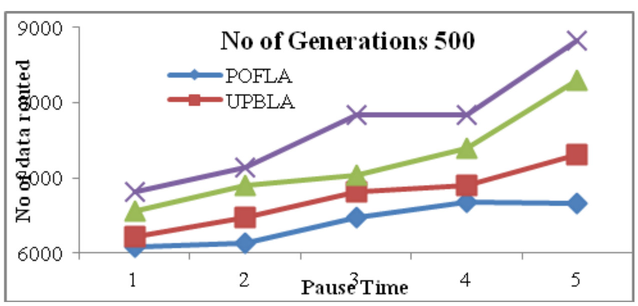

Fig.2 Result for no of generations is 500

In the figure 2, the number of data routed in POFLA and UPBLA are more or less same. There is an upward trend in curve for t=3 for all algorithms except MIPN. In t=3, there is an upward curve for MIPN and POFLA. The number of data routed in our new method and MIPN is very high as compared with other two methods. Overall performance of our new method with respect to number of data routed is very high.

As the number of generations is increased to 1000, for all t, the data routed is increasing in trend in figure 3. For t=1, the performance of UPBLA and MIPN is more or less same. For t>3, i.e. for t = 4 or 5, the difference between various methods is abnormally high. Overall performance of the new system is better than other 3 mentioned methods. The newly developed system can be benefitted if number of generations is increased to 1500, 2000 or 2500. If the size of network increased, surely the performance of the data access is also increased. Here both are related favorably.

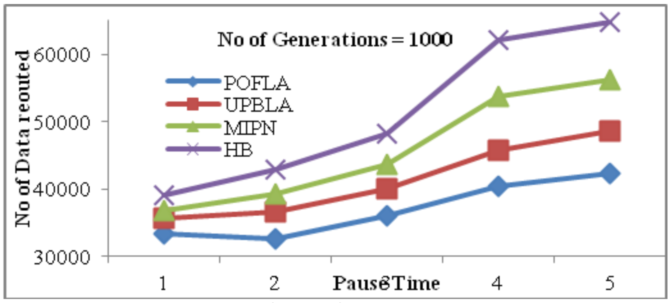

Fig.3 Result for no of generations is 1000

From the below figure 4, we have detected the following, the overall performance of the newly developed system with respect to number of data routed for location updation is comparatively less as compared to any other existing systems. The performance of MIPN is in zig-zag manner. For t=3, the number of data routed for MIPN and UPBLA are same. For t=4, MIPN and POFLA are same.

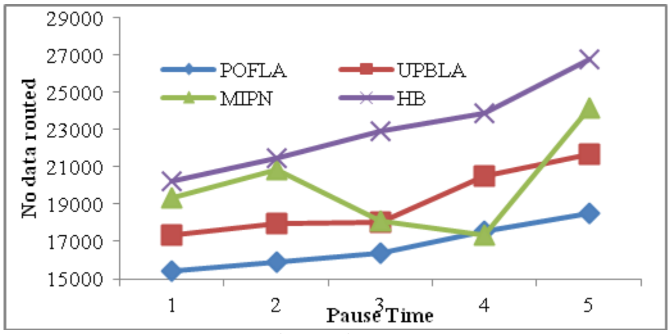

Fig. 4 Result for no of generations is 500

In the below figure 5, the total performance of the newly developed system is comparatively better. For all t, the number of data routed is increasing in trend with the exception for t=2 for POFLA. The performance of new system and MIPN is very meagre i.e. these two curves are coincident.

In the below figure 6, the overall total cost for our newly developed system is cheaper than other three algorithms. The initial point (CMR=1) for both UPBLA and MIPN are more or less same. The CMR from 1 to 10 is distributed in uniform manner. The points of CMR = 6,7,8 in our new algorithm is totally lie on CMR = 6,7,8 of POFLA.

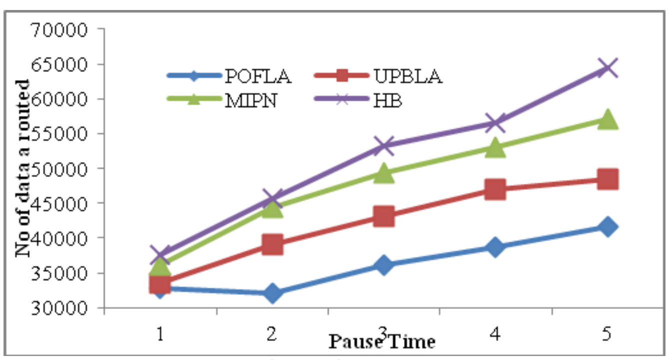

Fig.5 Result for no of generations is 1000

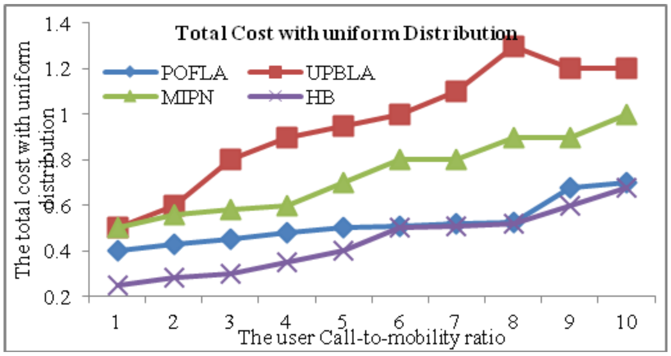

Fig.6 Total cost with uniform distribution

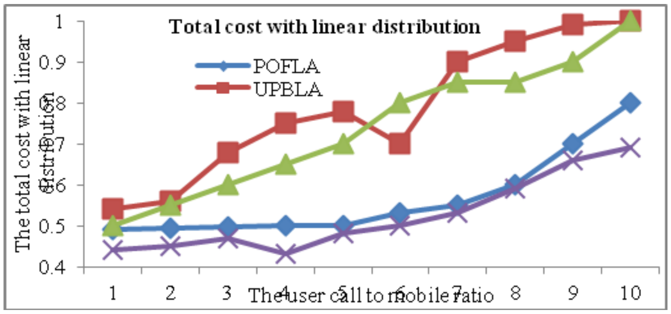

Fig.7 Total cost with linear distribution

In the figure 7, the overall performance of the new system is better than other three existing methods. The performance of UPBLA is not in uniform manner and the performance of POFLA is in uniform manner.

In the below figure 8, the performance of new system is comparatively better than other three methods. The new algorithm its points were n=very near to the points of POFLA. The difference between our new method and UPBLA is very longer.

The performance of our new algorithm its ranges are more or less same for both linear and exponential distribution i.e. the total cost is between 0.4 and 0.69 for all CMR. But in uniform distribution, the total cost between 0.25 and 0.69.

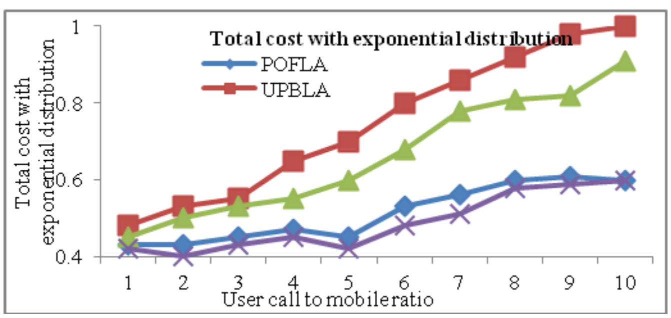

Fig.8 Total cost with exponential distribution

V. CONCLUSION

In near future we have a proposal to extend this network size up to 32X32, the number of generations up to 2,000 and the random number of data sets up to 16 cells to improve the performance. If we are implementing the new system in proper manner surely it will be very useful to real time generations and can get the optimum result. Popularity of wireless network is increasing day by day due to bandwidth and mobility support. Thus mobility management is an important characteristic for wireless network and it is not a tedious process, but it is very easy to implement. Location management is an integral part of mobility management and happens to be one of the factors that determine the performance of wireless networks. By integrating the intelligence with the mobility to achieve the pervasiveness surely we will reach the next generation. In the future the systems may need to manage a large amount of real-time information in addition to the locations of mobile clients. This structure may not be able to meet the real-time requirements of the systems since the number of mobile clients within a cell can be highly dynamic. The total delay in retrieving the real-time information will be highly unpredictable.

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