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Optimization of Location Management Cost by Mobility Pattern

Dr.S.Thabasu Kannan,
Principal, Pannai College of Engg & Tech,
Sivagangai – 630 561, Tamilnadu, India

N.Shakeela Banu,
Research Scholar,
PRIST University, Thanjavur

Abstract -- As *per one survey, every mobile user possesses two mobiles in the ratio of 1:2. Out of this 75% of the mobiles belongs to the category of smart phones. In this situation, the technology also fulfills the requirements for future advanced usage. Now-a-days mobile plays a pivotal role for connecting the global matters with in the hold of our palm. The main factor which influences the availability of mobile system in the market is speed and portability. Hence the speedy retrieval is the tharaga manthra pronounced in the minds of mobile users. In the instant world, time is the major constraint for the user who relies on the performance. If the system contains intelligence the reliability level of the system also increases, otherwise it will go down even to the point of zero. In this paper, we proposed a new mobility management schemes based on mobility pattern to minimize the total cost and to balance the Location update and search Paging. The new system its main aim is to get the speedy retrieval by using mobility pattern. 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. Here some cells in the network are designated as reporting cells, mobile terminals update their positions upon entering one of these reporting cells. Due to the popularity and robustness, Genetic algorithm is used to solve the reporting cells planning problem. The new system not only satisfies the requirements of the mobile environment but also fulfills the pervasive environment, because it integrates the concepts of mobile and intelligence. By use of this intelligence, the extraction of output and its level of accuracy are very high. Here intelligence is used to identify the shortest path. The main drawback here is same time taken for first call and maintain less time for subsequent calls only. The performance of the new system can be tested by generating random data sets for number of generations 500 and 1,000, the network size taken is 4X4. Here we have evaluated the performance of the new system by comparing with some existing systems like POFLA, UPBLA and MIPN. The performance can be measured by call-to-mobility ratio, locating time ratio, the update cost ratio, time-data routed ratio. Comparatively the new system is better than any other existing system we have mentioned.*

Keywords: location updates – location paging – mobility pattern – call to mobility – cells – vicinity – reporting cell -

1 Previous study

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

2 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

3 Network Structure

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.

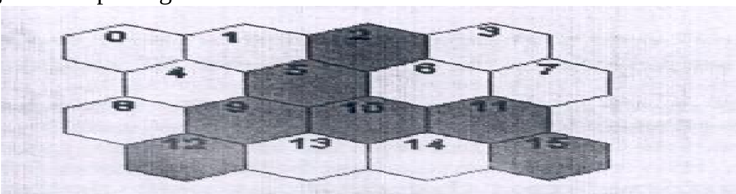

Fig.1 Network with reporting cells

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.

4 Procedure for finding Vicinity

(a) 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.

(b) 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 fig 1, 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.

$$N_{LU} = \sum_{i \in s} W_{mi}$$

$$N_P = \sum_{j=0}^{N-1} W_{cj} * V(j)$$

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)

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

5 Mobility pattern 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

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

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

Here if we keep h=1, the NW_{mi} ➔ 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.

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

$$NW_{cj} = W_{cj} * \left[\frac{NW_{mi}}{W_{mi}} \right]$$

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 :

$$N_{P'} = N_{P1} + N_{P2} + N_{P3} + N_{P4}$$
$$Total\ cost = C.N_{LU} + N_{P'}$$

6 Genetic Algorithm

This algorithm [3,8] 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. The standard genetic algorithm proceeds as follows: an initial population of individuals is generated at random. The current population are decoded and evaluated according to some predefined quality criterion (fitness). For the next generation, individuals are selected according to their fitness. This ensures that the expected number of times an individual is chosen is approximately proportional to its relative performance in the population. Thus, *high-fitness* individuals stand a better chance of *reproducing*', while *low-fitness* ones are more likely to disappear. It contains three operators viz reproduce (used to select the best cell for next generations), crossover (to create new cells by exchanging properties between cells) and mutation (used to Invert the selected cells).

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7 Performance Evaluations

TABLE 1
DATASET1 FOR 4 X 4 NETWORK

Cell	W_{ci}	W_{mi}	Cell	W_{ci}	W_{mi}
0	317	318	8	51	245
1	373	574	9	24	1149
2	55	53	10	641	1458
3	107	1496	11	500	752
4	442	1417	12	25	107
5	751	272	13	340	185
6	326	450	14	495	1146
7	309	169	15	125	372

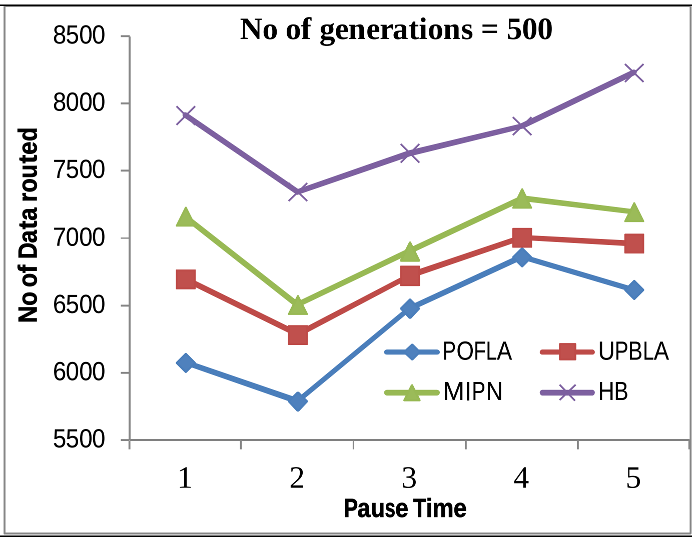

Fig2: Result for no of generations is 500

In the figure 2, initially the number of data routed in various methods and its difference is high. The ratio of data routed to time for our newly developed system is very high as compared with other existing systems like POFLA, UPBLA and MIPN. For all t > 1, the time difference between various existing methods is very low. As the number of generations is increased to 100, for all t < 4, the variation between various methods is very meager. .

TABLE2
DATA SET2 FOR 4 X 4 NETWORK

Cell	W_{ci}	W_{mi}	Cell	W_{ci}	W_{mi}
0	417	418	8	151	245
1	473	574	9	124	1149
2	55	53	10	741	1458
3	207	1496	11	500	752
4	542	1417	12	25	107
5	851	272	13	440	185
6	426	450	14	595	1146
7	409	169	15	125	372

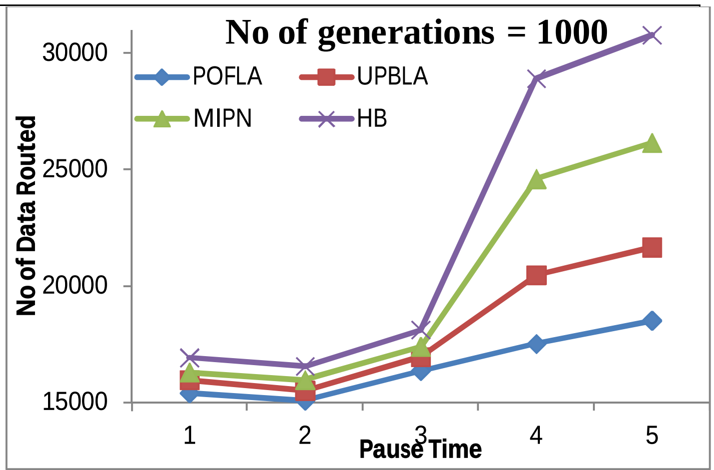

Fig3: Result for no of generations is 1000

In the below figure3, 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. For POFLA, the ratio for t = 3,4 &5 is straight. For UPBLA, MIPN and our newly developed system, the data routed for t=4 is heavily increased as compared with any mother t. 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 favourably. From the below figure 4, we have detected the following, the overall performance of the newly developed system with respect to user locating time is comparatively less as compared to any other existing systems. The user time locating ratio for CMR is inter-twined. The CMR above 3, the user locating time ratio is increased in high manner. The user time locating ratio is generally increased in our newly developed system. The performance of UPBLA is also increased gradually.

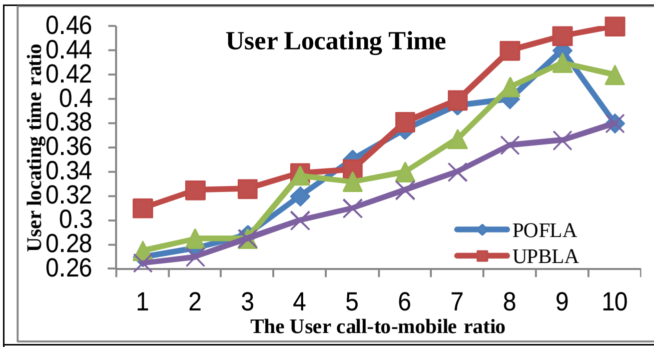	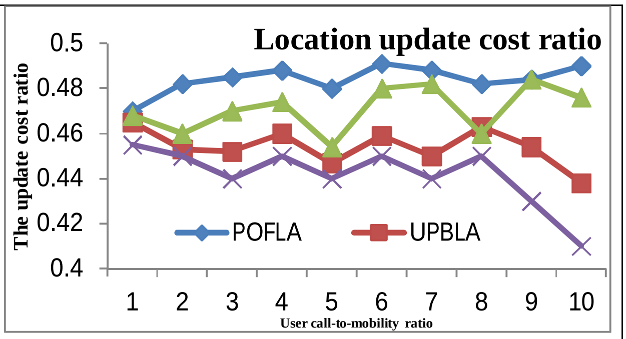
Fig4: User locating time	*Fig5: location update cost ratio*

In the below figure 5, the total performance of the newly developed system is comparatively better. Initially the curve for new system is downward. Hence initially the update cost ratio is high and gradually decreased and CMR after 8 is abnormally decreased. The performance of UPBLA is comparatively close to our new system. The performance of POFLA is not preferred, because the update cost ratio is heavy. The mid of CMR clearly forms a V-bend curve.

CONCLUSION

In near future we have a proposal to extend this network size up to 32X32, the number of generations up to 1500 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 daydue tobandwidth 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. So, location management is attracting more and more research attention. 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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