

A Novel Profile based Paging in Dynamic Cellular Network

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Abstract—Location management is an important and very crucial problem in mobile cellular network. Proper management in locating a mobile device effectively in a mobile computing environment is mobility management or location management. This management process achieved by two techniques known as location update and location inquiry or paging. Location inquiry technique performed by the mobile network while location update job is performed by the mobile device itself. During the call arrival to a user, to know the exact location of the user, location inquiry works along with location update. In this paper, proposed profile based paging algorithm compared on the basis of bandwidth conservation and paging success rate with the other various paging algorithms explored by other authors. In this work taken a novel real data collected from a service provider farm for profiling the mobile users and have validated the algorithm with the original data of the user. When compared the proposed algorithm with conventional paging and sequential paging, 2 to 8 percent better paging success rate and saves 50% to 30% of the bandwidth is achieved.

Keywords—Mobile terminal, Mobility management, Per call management data (PCMD) or call data record (CDR) data, paging traffic, Profile-based paging.

I. INTRODUCTION

Location management is a crucial component mobile communication. It means to the set of techniques that assists in finding the exact location of the mobile device in a mobile computing environment. Location update and paging are the two main basis of location management. Location update informs the MSC about the current location of the device [1]. Paging on the other hand informs the Mobile Device regarding any incoming message. These two technologies are inter related and they share a tradeoff [2]. With the decreasing location update frequency, the uncertainty in user's location increases which in turn increases the paging cost. And when the location update frequency increases (which is directly proportional to location update cost), there is a reduction in paging cost as the probability of user's location prediction increases [3].

Location management utilizes bandwidth from the available pool of bandwidth so although location management is very crucial component lack of optimization of location will result in lack of bandwidth for voice and data communication [4]. In the current scenario where service providers are struggling to pack users into the limited amount of spectrum. Spectral efficiency is a deciding parameter. In this paper optimization of paging resource utilization is the matter of interest and the different paging techniques in terms of spectral efficiency and paging success rate are compared [5-6].

II. CHARACTERISTIC OF PAGING CHANNEL

Paging usually managed by common control channels. The operation of paging channel is similar both for CDMA and GSM. All the mobile devices use the same paging channel in the same cell of a geographical area. The preserved power is reduced by the mobile device when monitoring the paging channel periodically. Generally paging channel includes 80ms slots out of which 32 to 64 slots present in each paging cycle. For a specified mobile, the paging is to broadcast information at a particular time slot in a cycle [5]. Identification of the mobile is based on its IMSI (International Mobile Subscriber Identifier) or TMSI (Temporary Mobile Subscriber Identifier) it is provided by the BTS) or [6].

Performance of a paging is judged by three important parameters

1. Paging success rate
2. Paging delay
3. Bandwidth requirements

1. Paging success rate

It is determined as the ratio of successful pages to that of total number of pages. The higher the paging success rate the better is the system. For an operational value the paging success rate should be more than 80%. Paging is generally done multiple times to locate the user. The value given here is the cumulative sum of all the paging success rate. So if the paging success rate of the 1st paging is 70% and that of the second paging is 20% then the net paging success rate at the end of second paging is 90%. A higher paging rate not only implies a better algorithm to locate the user but also decreases the paging delay [7].

2. Paging delay

This is another deciding factor of paging. It takes some time between the initiation of paging request and the paging request being acknowledged by the user. Paging delay is given as the time difference between these two events. For a better user experience and system stability improvement it should be kept as small as possible [8].

3. Bandwidth requirements

Paging utilizes the available frequency. So an increase in paging load will reduce the bandwidth available for voice and data communication and will ultimately hamper the GOS (Grade of service) of the system. Also considering the current scenario where the number of users is increasing in an exponential manner. Spectral efficiency is an essential characteristic [9].

B. Problem formulation

III. PAGING CLASSIFICATION

In a broad sense, to locate a user paging can be divided into three types. These are categorized as follows:

1. Profile based paging
2. Sequential paging
3. Blanket paging

A. Profile Based paging

Profile based paging is relatively a more younger idea. Like successive paging it considers user probability of presence however alongside that it considers user behavioral example from the previous. The outcome so got is a refined inquiry area (paging area) that further lessens the bandwidth capacities and enhances the probability of user. Profile construct paging works in light of the way that client's conduct is unsurprising in the event that we have the learning of user's history. The different parameters monitored for profiling the user are user movement pattern, call arrival rate, call arrival time etc. These parameters make the user behavior more predictable. The advantage that we get out of this is more bandwidth conservation. For instance if a user indicates less development in the past then it can be securely anticipated that the user. Whereas a user with very high degree of movement indicates that the paging area need to be large to reduce the paging delay. In this way profile based paging tries to optimize the spectrum used while not compromising with the paging delay.

B. Sequential paging

From the name it is understood that, in a sequential way the paging or search of the mobile user is done one by one. In a particular location area the cells are clustered of smaller groups and accordingly these clusters are named as paging areas or search area. The gathering having the most probability likelihood of finding the user is paged first. What's more, the consequent pages are done in a diminishing request of likelihood of finding the user. In this technique the bandwidth requirement is considerably less compared to Blanket paging as we are only paging a small portion of location area. The only concern of sequential paging is paging delay. As the LA is divided into small segments the probability of finding the user comes into the picture. And the size of the paging area is directly proportional to the probability of locating the user. So the sequential paging has to trade-off between bandwidth conservation and paging delay. To lessen the paging delay the principal paging region is made with high likelihood of finding the client. The run of the mill likelihood qualities are 0.90 to 0.95 for ideal paging deferral and data transmission preservation. Successive paging breaks the paging load over various parts of the area. This lessens the system clogs and different issues that are connected with show paging and makes the framework more steady and strong. In terms of system requirements it requires better computational resources to dynamically calculate the user probability and design the Paging Area. The execution expense is somewhat high contrasted with cover paging yet the favorable circumstances it produces are overpowering. This is the reason the vast majority of the administration

suppliers are receiving successive paging slowly. It offers 10% to 20% of the aggregate paging [10].

In this present work the described sequential paging is named as Hypo-LA paging described in [11]. Hypo-LA paging uses the cell ID reported in the last known location update to determine the paging area. So the first paging area consists of the reported cell and cells in the vicinity of that cell. And the other cells are grouped into subsequent paging areas. The best possible dimension they found for paging region is one BSC which comprises of 400 on a normal number of cells. The perception referred to in the paper are utilized for correlation with the proposed paging.

C. Blanket paging

The most traditional and common type of paging is blanket paging. In this type the paging is done for the total location area at once. This blanket paging is also commonly known as broadcast paging. The paging success rate remains high in normal condition but, a huge amount of bandwidth is consumed in this type of paging. There is a reduction in available band width for voice calls and other controlling activities as a result; the grade of service (GOS) of the cellular system is hampered. The available channel reduction during peak hours increases the waiting time and average time in the system for users. As the load on MSC increases cumulatively, it leads to system failure finally with huge number of call drops. So, during peak hours the paging success rate is extremely low in this kind of paging. These pging systems are the cheapest as the system requirements are minimal in terms of implementation cost and computational requirements. But currently almost 80% to 90% of the paging is occurred as blanket paging or broadcast paging due to non availability of advanced technology.

In this work we had proposed a profile based paging algorithm and had contrasted it and compared with other algorithms. The projected profile based calculation uses the client's periodicity to lessen the paging load and advance the asset use. A large portion of the user carry on occasionally that is whether you are an office laborer or an under study then your day by day movement are very connected. Which infers if Friday at 11 am you are at area 'A', then there is a high likelihood that on the following Friday at 11 am you will be at area 'A'? So if a call lands around 10 am on Monday then the proposed calculation pages cell "A" first then alternate cells. The proposed calculation separates these occasional examples in user development and improves the paging as needs be. The proposed calculation gains from the user conduct and build up a dynamic paging region that depends on periodicity in user development. [12].

IV. PROPOSED ALGORITHM

A. PCMD Traces

Utilizing PCMD data the proposed paging profile the users. Here Per Call Measurement Data or PCMD also known as CDR. In MSC It is initiated for individual user and their call activities are recorded.

About the user's calling pattern and movement pattern is provided by this CDR data Such as Call time and date. Called number, Call type, Call duration, Number of events ,served MSISDN, Network ID ,cell Identifier etc.

We have used these PCMD data to profile the user. Profiling was to be able to extract the periodicity in user movement is the main objective of the work. Here the calling time and date, Cell ID at the time of call and the location area are the three main fields considered for profiling.[12].

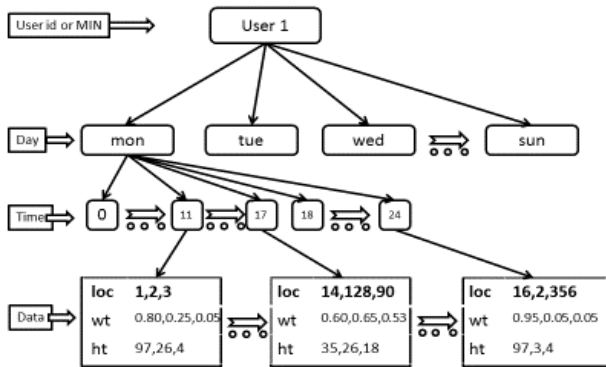


Fig 1: User Profile

The cell ID put in **Loc**, the user has moved in the past at the specified time. **Wt** represents the weight or probability of the user being available in that **cell ID** at that specific time. **Ht** remains for history. It records the quantity of time the user has been available at the same area previously. This information base is upgraded at consistent interim of time where new cells if went to by the user are added to the loc exhibit and old cells with less **Wt** qualities are expelled from the cell. The **Wt** vector likewise gets redesigned to portray the adjustment in user probability after some time

V. SIMULATION AND RESULT

A. Results of profile based paging algorithm

The suggested algorithm is simulated with MATLAB over a period of 6 weeks with 320 real data samples. The observations that we obtained are represented below.

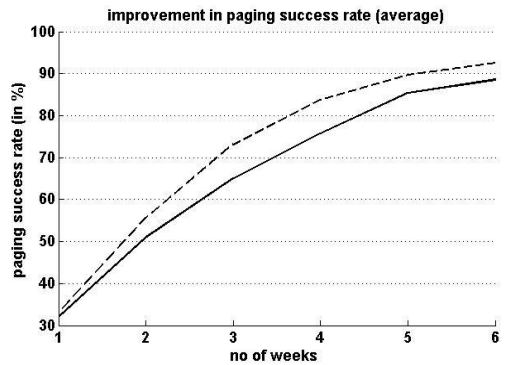
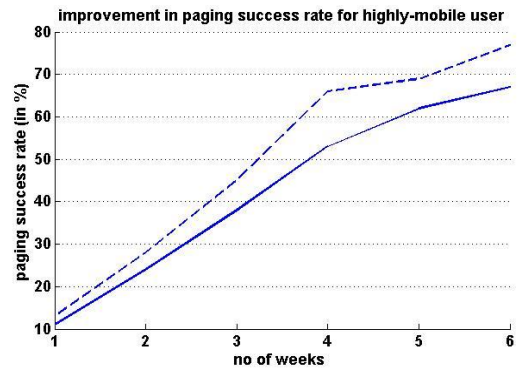
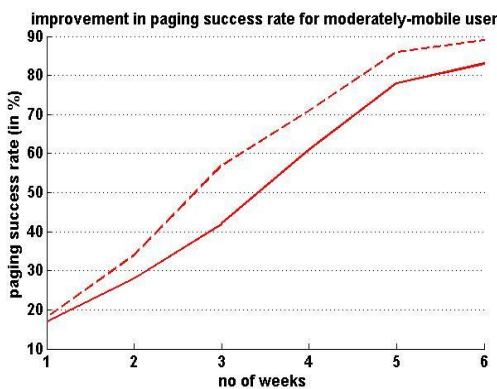


Fig 2: Different users Paging success rate

These graph presents the paging success rate over different weeks. The observations at the end of 6th week are presented in the table:

B. User Database or Profile

The obtained data are placed in a profile as given bellow

Table 1 :Paging Success rate of number of cells paged

Type of user	Number of cell paged		Paging success rate	
	First paging	Second paging	First paging	Second paging
Less-mobile	8 cells (Max)	35 cells (Max)	95%	97%
Moderately-mobile	19 cells (Max)	47 cells (Max)	83%	89%
Highly-mobile	36 cells(Max)	102 cells(Max)	67%	77%

The obtained results are compared with commonly used paging techniques to show a comparative of improved paging characteristics of the proposed paging scheme.

C. Analysis of Blanket paging charecteristics

The leading telecom provider in India provides paging characteristics (Blanket paging) for a comparative study. Average paging success rate over different weeks are present below in tabular form[12].

Table 2 :Number of weeks Paging success rate

Number of weeks	Paging success rate
week 1	77.13
week 2	84.95
week 3	80.58
week 4	79.16
week 5	80.75
week 6	78.20

Table 4 : Comparison of different paging

Type of paging	Paging success rate after 1 st paging(Average)	Paging success rate after 2 nd paging(Average)
Blanket Paging	80	85
Sequential Paging	87	91
Profile Based Paging	89	93

D. Paging characteristics of Hypo-LA paging

The table below summarizes the observations regarding Hypo-LA paging.

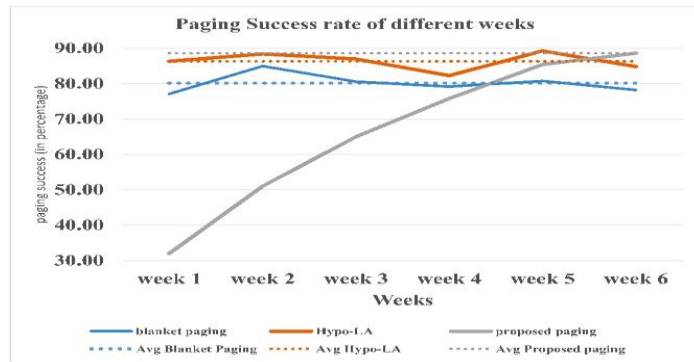


Fig 3: Paging success rate of different paging in different weeks

Table 3 : First and Second Paging of Hypo-la paging

	Hypo-la paging
First Paging type	TMSI
First Paging area	BSC (300 cells on avg.)
1 st paging Success rate (in %)	85.15
Second paging type	IMSI
Second paging area	LA (600 cells)
2 nd paging Success rate (in %)	91

It is conclude from the graph that higher paging success rate compared to blanket paging over 6 weeks achieved in sequential paging. Whereas acceptable paging success rate after the 5th week obtained in the proposed paging. It is clearly observed that the paging success rate follows similar trend enen after second paging.

The average paging success rate is summarized in Table 4 after end of 6th week.

1. In terms of bandwidth conservation

The accompanying diagram pictures the evaluated data transfer capacity necessary for the distinctive sorts of paging as bandwith requirement is specifically corresponding to the quantity of cells paged.

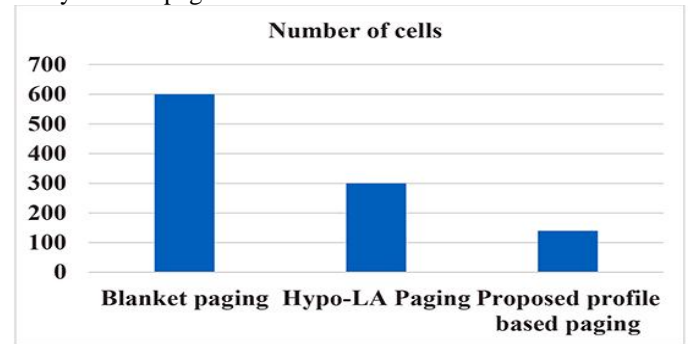


Fig 4: Comparision of paging success rate of different paging

This demonstrates the proposed paging is twice proficient when contrasted with the consecutive paging (Hypo-LA paging) and three times more effective contrasted with Blanket paging.

VI. CONCLUSION AND FUTURE WORK

The proposed profile based paging algorithm surpasses both the blanket paging and sequential paging in all the aspects. It gives a paging success rate that is 8% more than the blanket paging and 2% more than sequential paging. The proposed algorithm does so while using 50% of the bandwidth used by the sequential paging and using 33% bandwidth used by Blanket paging. So at the current scenario where bandwidth conservation is of utmost importance. The proposed profile based paging can be the perfect solution. And the delay generated is the same compared to the blanket paging. So the proposed paging algorithm can be implemented with the existing system for a period of 5 to 6 week and then the system can work alone.

In our future work we are attempting to build up a dynamic client profile that will promote lessen the support expense of the profile and will facilitate improve the paging achievement rate. The future work likewise incorporates a cost estimation for the usage of the proposed algorithm.

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