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Analysis of Dynamic Channel Allocation based on Blocking Probability for Cellular Networks

Remika Ngangbam[1] ,Pragati Singh[2] ,F. Lalrinfeli[3]
[1,2,3] National Institute of Technology Mizoram, Aizawl – 796012 , India

Abstract: ***The tremendous growth of wireless or mobile user population, coupled with the bandwidth requirements of multimedia applications, requires efficient reuse of the scarce radio spectrum and efficient channel allocation to mobile users or wireless communications. Channel allocation schemes can be categorized into fixed channel allocation (FCA), dynamic channel allocation (DCA) and hybrid channel allocation (HCA) schemes.DCA is further categorized into centralized and distributed DCA. Many papers have been worked out on efficient channel allocation and frequency reuse method for cellular networks. In this paper, channel allocation is mainly concernedin distributed DCA where the interference constraints (CNIR) play the main role in assigning channel to the users. The simulation result which has been simulated based on some cost function parameters of DCA shows that the supportable traffic in a cell can be easily determined with the knowledge of blocking probability beforehand, i.e., when the simulation blocking probability and theoretical blocking probability are almost same the traffic that can be supported by a cell can be determined theoretically.***

Keywords: **Blocking probability, cell mesh, CNIR, Distributed DCA.**

I. INTRODUCTION

In cellular network channel allocation deals with the allocation of channels to cells. Once the channels are allocated, cells may then allow users within the cell to communicate via the available channels.In radio resource management for wireless and cellular network, channel allocation schemes are required to allocate bandwidth and communication channels to base stations, access points and terminal equipment. The channel allocation scheme objective is to achieve maximum system spectral efficiency in bits/second/Hz/site by means of frequency reuse with the assurance of a certain grade of service by avoiding co-channel interference and adjacent channel interference among nearby cells or network that share the bandwidth.

In cellular radio systems, an intelligent allocation and reuse of channels is used throughout a coverage region, where each cellular base station is allocated a group of radio channels to be used within a small geographic area called a cell. The base stations in adjacent cells are assigned channel groups which contain completely different channels fromneighboring cells. The base station antennas are designed to achieve the desired coverage within the particular cell. By limiting the coverage area to within the boundaries of a cell, the same group of channelscan be used to cover different cells that are separated from one another by distanceslarge enough to keep interference levels within tolerable limits. Thedesign process of selecting and allocating channel groups for all of the cellularbase stations within a system is called Frequency reuse or frequency planning. In a dynamic channel allocation method, all channels are potentially available to all cells and are assigned to cells dynamically as calls arrive. If this is done with an efficient dynamic channel allocation method, it can take advantage of the temporary changes in the spatial and temporal distribution of calls in order to serve more users. Therefore, when calls are concentrated in a few cells and requires more channels, then the system will borrow idle channels from cells that have unused channels, and these high-traffic cells can be assigned more channels without increasing the blocking rate in the lightly used cells. Many research works have been done on channel allocation and blocking probability like reduction of call blocking probability in hot spot scenario HCA scheme [1], efficient channel allocation algorithm in cellular networks [2], [5], [8] but no paper has discussed about the supportable traffic of a cell. The main objective of this paper is to show that the supportable traffic load in a cell can be easily determined if the blocking probability of theoretical and simulation comes out to be almost same.

II. SYSTEM MODEL

The mobile cellular network is regular grid of hexagonal cells of radius R. The cells are organized as (N X N) array as shown in Fig. 1.The hexagonal representation of a cell has exactly six equidistant neighbors and the

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lines joining the centers of any cell and each of its neighbors are separated by multiples of 60 degrees, hence there are only certain cluster sizes and cell layouts which are possible.

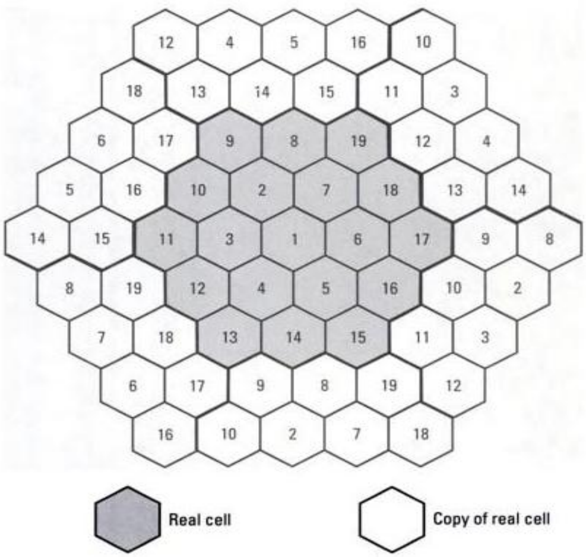

Fig.1 Cells structure

It is assumed that there are 19 hexagonal cells having a cell radius of 1. These cells are determined by the positions of the 19 base stations.Regulated numbers of users are scattered in each of the 19 cells from which data are taken. User distribution is considered to be uniform over one cell as well as the entire cell layout. Such a condition is realized by cells distributed into a lot of small meshes.Cell mesh is the possible spot where the user may be located and is determined by the parameter fineness.Fineness is a parameter for cell mesh and is defined as distance between two cell meshes and is usually set to fineness=50.Here, discrete meshes are used to allocate a certain amount of traffic into the hexagonal cell. If a larger value of fineness is introduced, such a discrete mesh structure gets close to the continuous distribution model.

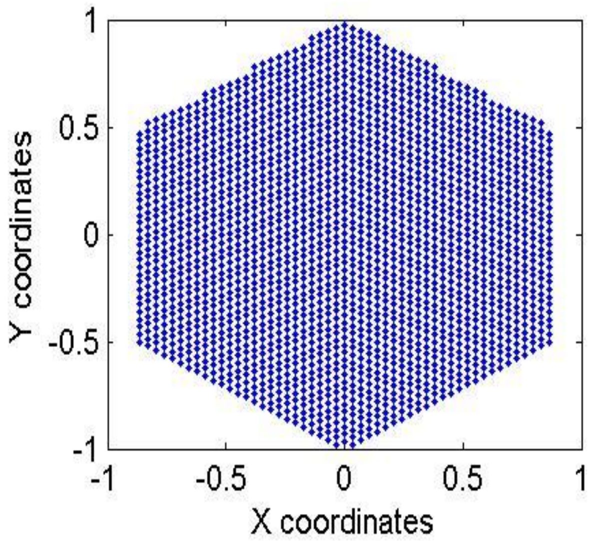

Fig.2 Cell mesh structure for fineness=50

III. DYNAMIC CHANNEL ALLOCATION (DCA)

In DCA, a channel is eligible for use in any cell providedthat signal interference constraints are satisfied because ingeneral more than one channel might be available in the centralpool to be assigned to a cell that requires a channel.The main idea of all DCA schemes is to evaluate the cost ofusing each candidate channel, and select the one with theminimum cost provided that certain interference constraintsare satisfied. The selection of the cost function is what differentiatesDCA schemes. The selected cost function might depend on the futureblocking

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probability in the vicinity of the cell, the usage frequencyof the candidate channel, the reuse distance, channeloccupancy distribution under current traffic conditions, radiochannel measurements of individual mobile users, or the averageblocking probability of the system. There is no set relationship exists between channels and cells in DCA systems. Instead, channels are part of a pool of resources. Whenever a channel is needed by a cell, the channel is allocated under the constraint that frequency reuse requirements cannot be violated.

In distributed DCA schemes the assignment of channel to a cell is based on carrier to noise interference ratio (CNIR) constraints denoted by R_{cni} unlike centralized DCA schemes which assign the channel based on FA(first availability) and is given by

$$R_{cni} = \frac{A P_0 d_0^{-\alpha} 10^{\frac{\xi_0}{10}}}{N + \sum_{i-1}^{3} A P_i d_i^{-\alpha} 10^{\frac{\xi_i}{10}}} \quad (3.1)$$

Where,

α is the path loss factor
A is a proportional constant
P_i is the transmitted power of user T_i
d_i is the distance of T_i from R_0
ξ_i is the distortion caused by shadowing between T_i and R_0 (dB)
*N*is noise of the channel

IV. PERFORMANCE EVALUATION

Several metrics can be used to evaluate theperformance of the proposed algorithm. In this paper, only themost important metric of *call blocking (denial) probability*and *force termination probability* are considered. The call blocking probability is defined as theratio of the number of new calls initiated by a mobile hostwhich cannot be supported by existing channel arrangement tothe total number of new calls initiated (i.e., a call arriving to acell finds both fixed and dynamic channels busy).Forced termination probability is defined as the statistical probability that a connected call will be interrupted before its conclusion. Blocking probability P_{bl} and forced termination probability P_{fe} are given as follows:

$$P_{bl} = \frac{block_{num}}{call_{num}} \quad (4.1)$$

$$P_{fe} = \frac{force_{num}}{call_{num} - block_{num}} \quad (4.2)$$

Introducing of these two performance measures enable several potential evaluations of a cellular system.
Theoretically, the blocking probability can be calculated by using the formula:

$$P_{bl-theo} = \frac{\left(\frac{n-1}{s}\right)(vh)}{\sum_0^1 \left(\frac{n-1}{i}\right)(vh)} \quad (4.3)$$

Where n and s are the number of users and channels respectively, v and h are the average call arrival rates per non connected users and the average call holding time, which respectively corresponds to λ and ht in this simulation.

V. SIMULATION PARAMETERS

The simulated cellular network consists of a 2D structure of 19 x 19 hexagonal cells, with eachcell having six neighbours. There are 600 channels in total in thesystem. A frequency reuse factor of 3 is assumed (i.e., ***N*** = 3).The arrival of calls at any cell is assumed to be a Poissonprocess and that the call duration is exponentially distributed with a mean of 3 minutes. The mean call arrival rate ina normal cell is λ calls per minute and ht is average call duration of a user.

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VI. SIMULATION RESULTS

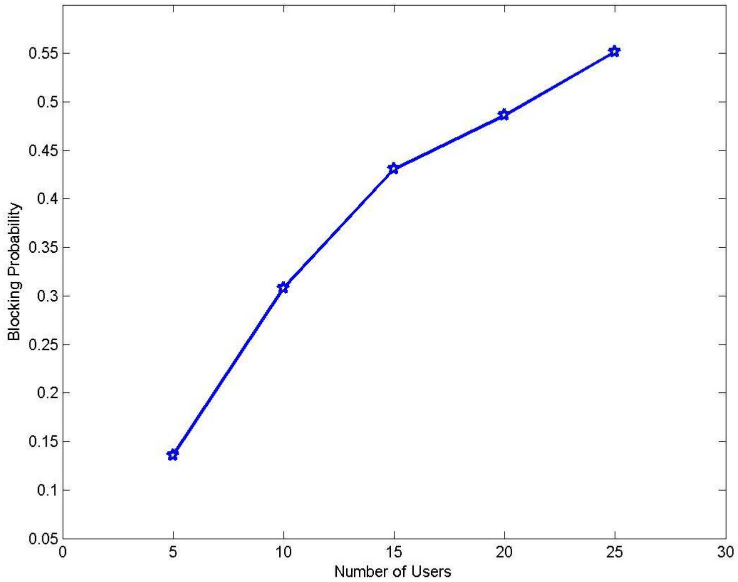

Fig.3 (a) Blocking Probability vs Number of Users

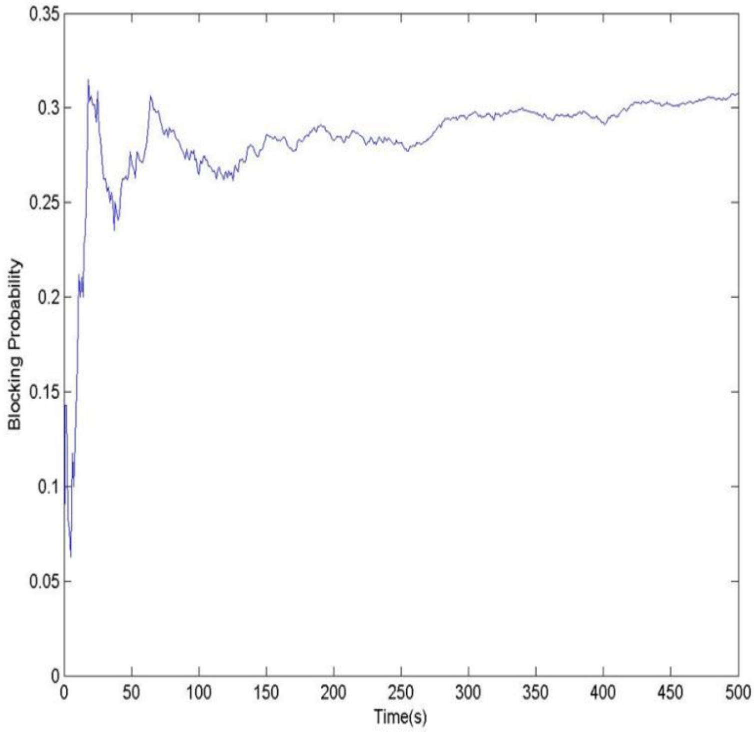

Fig. 3(b) Blocking probability vs time instant for 10 users

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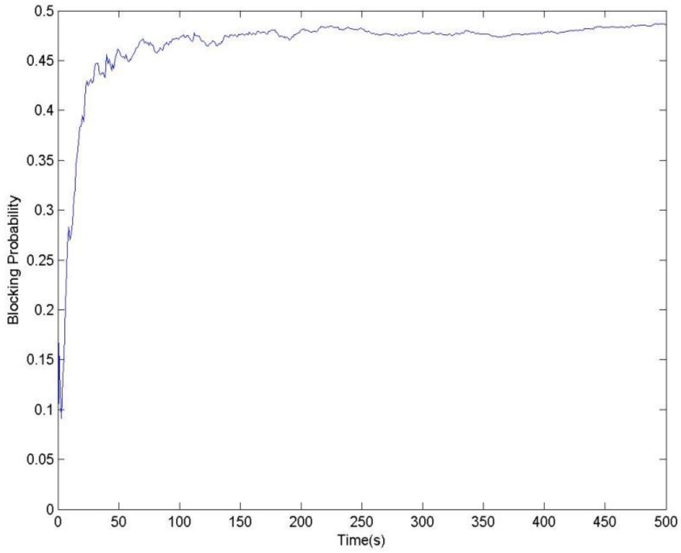

Fig. 3(c) Blocking probability vs time instant for 20 users

The following table shows the simulation blocking probability values when number of users per cell is 5, 10, 15, 20 and 25.

Table I

User Number	5	10	15	20	25
Call Number	657	1436	2189	2958	3742
Block Number	89	442	943	1438	2064
Blocking Probability	0.135464	0.307799	0.43079	0.486139	0.551577

The simulation is done using the discrete event simulation model and the call blocking probability is studied for different users under various system parameters.The simulation graph Fig.3(a) shows that the theoretical ( ) and simulation ( ) blocking probability are almost the same which further shows that the supportable traffic of a cell can be easily determined beforehand.

VII.CONCLUSION

Dynamic channel allocation is based on either first availability channel assignment or interference constraints threshold value satisfaction. The simulation study which has been simulated based on cost function parameters (like average call arrival rate, usage frequency of the candidate channel,etc) shows that the simulation and theoretical blocking probability becomes almost the same which further indicates that the supportable traffic can be easily determined with the knowledge of theoretical blocking probability beforehand. In future we can try to increase the efficiency of a cell for larger cellular networks with reduced blocking probability.

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AUTHOR BIOGRAPHY

[1]Remika Ngangbam is currently working as Assistant Professor in National Institute of Technology, Mizoram under Electronics and Communication Engineering department since February 2014. She has received her B.E. (Electronics and Communication Engineering) from Anna University, Coimbatore in 2011 and M.E. (Communication systems) from Anna University, Chennai in 2013. She has published one paper in international journal, two papers in international conference proceedings and one paper in national conference proceeding. Her area of interests include cognitive radio, wireless and mobile communication and optical communication.

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[2]Pragati Singh is currently working as Assistant Professor in National Institute of Technology, Mizoram under Electronics and Communication Engineering department since January 2014. He has received his B.Tech. (Electronics and Communication Engineering) from Uttar Pradesh Technical University (UPTU), Lucknow, UP in 2009 and M.Tech. (Microelectronics and VLSI design) from NIT Silchar, Assam in 2013. He has published one paper in international journal. His area of interests includes solid state device modeling and simulation, VLSI, digital electronic and electronic circuits

[3]L. Felrenfeli has completed her B.Tech. (Electronics and Communication Engineering) under National Institute of Technology, Mizoram in 2014. Her area of interests' includeswireless and mobile communication and satellite communication.