Undergraduate Academic Research Journal

Volume 1 | Issue 1 Article 6

July 2012

Dynamic Channel Allocation Considering Random User Distribution and Mobility

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Recommended Citation

Vora, Rushabh; Tamboli, Sagar; Shah, Priyanshu; and Kulkarni, Sukanya (2012) "Dynamic Channel Allocation Considering Random User Distribution and Mobility," *Undergraduate Academic Research Journal*: Vol. 1 : Iss. 1 , Article 6.
Available at: https://www.interscience.in/uarj/vol1/iss1/6

Dynamic Channel Allocation Considering Random User Distribution and Mobility

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Abstract - Recently, heavy traffic in the spectrum with interference being the most prohibiting factor has given rise to the need for efficient channel assignment techniques to increase the overall system capacity. In this paper using MATLAB we provide a comparison between fixed channel allocation (FCA) and dynamic channel allocation (DCA) which attempts to allocate channels to users in such a way so that the average blocking probability and forced termination in the entire system is minimized. Further in contrast to traditional DCA schemes we have considered random user mobility and traffic variations to study forced termination probability.

Keywords *- Cellular network, dynamic channel allocation, random user distribution, user mobility.*

I. INTRODUCTION

The exponential increase in the number of users and the paucity of wireless spectrum poses a challenge for the technicians to increase the system efficiency so as to accommodate as many users as possible in the available limited but very precious spectrum. The increasing number of higher data rate devices clearly states that dynamic channel allocation with some innovative techniques will help solve the problem of spectrum efficiency. With these DCA schemes, spectrum will be allocated dynamically depending on need of the service and providers that in turn depends on end users' demands in a time and space variant manner. Here, each node performs rapid spectrum sensing to detect spectrum holes and distributed coordination to use them.

A. Channel allocation

A given radio spectrum can be divided into a set of disjoint or non interfering radio channels. All such channels can be used simultaneously while maintaining an acceptable received radio signal. Reliable and efficient channel allocation management as given in [1] is vital for the growth and innovation of wireless technologies and services in Next Generation Wireless Networks.

B. Types of channel allocation

Fixed channel allocation (FCA) - Here the area is partitioned into a number of different cells and a number of channels are assigned to each cell according to some reuse pattern depending upon the reuse quality. FCA schemes are very simple, however they do not adapt to changing traffic conditions and user distribution. In order to overcome these FCA deficiencies DCA strategies have been introduced.

Dynamic channel allocation (DCA) - As opposed to Fixed Channel Allocation (FCA), in Dynamic Channel Allocation (DCA) as given in [2] there is no fixed relationship between channel and cells. All channels are kept in a central pool and are assigned dynamically to radio cells as new calls arrive in the system. In DCA as given in [3], a channel is eligible for use in any cell provided that signal interference constraints are satisfied.

C. Proposed method

In contrast to traditional call-by-call DCA schemes, where the channel assignment is based only on current channel usage conditions in the service area, in this work we considered a mobility-aware DCA algorithm in which the channel assignment is adaptively carried out using varying positions of users in the system. Also it has the main feature of reallocating a channel to an ongoing call if the quality of the communication channel decreases below certain level based on the interference level experimented at the receiver; this is made without disconnecting the call. Hence, in this paper we present work in progress about dynamic channel allocation considering the mobility of users along with interference in such a way that average blocking probability and forced termination in entire system is minimized.

II. SYSTEM MODEL

A. *Interference*

Interference is a fundamental nature of wireless communication systems, in which multiple transmissions often take place simultaneously over a common communication medium. It can stem from a variety of causes. Generally, the interference starts at a base-station transmitter (Tx), either from the same cellular system or from a nearby Tx. The interference can result in dropped calls, decreased receiver (Rx) sensitivity (and range), increased Rx noise figure and desensitization of receive-system active components.

Two metrics are used to evaluate system performance: Blocking probability and Forced Termination probability. The blocking probability is defined as statistical probability of losing a call either due to the lack of available channels or that available channels are experimenting too much interference. The forced termination probability is statistical probability of a call that is forced to terminate prematurely either due to non-availability of channel in new cell or excess interference on existing channel.

B. *Carrier to noise interference ratio (CNIR)*

The ratio between the power of the carrier signal and the power of all interfering users plus noise (CNIR) is a measurement used to determine the interference levels experimented in some point of communication link. The CNIR is calculated according the following expression:

$$\text{CNIR}=\frac{P_t d_t^{-\alpha} 10^{\frac{\varepsilon_0}{10}}}{N_0+\sum_{i=1}^{k} P_i d_i^{-\alpha} 10^{\frac{\varepsilon_0}{10}}} \qquad (1)$$

Where P_t is transmitter power, d_t is the distance between transmitter and receiver, α is an attenuation factor, the term 10^(ε_0/10) denotes the loss due to log-normal shadowing, N_0 corresponds to noise power. The sum term represents the total interference due to the k users using the same channel, transmitting with a power P_i at a distance d_i from receiver. As is previously mentioned, the algorithm proposed allocates and re-allocates channels based on a measurement of interference levels and user. In this algorithm, CNIR measurement is used in order to make decisions on whether a channel can be assigned to a call or not.

C. *Channel allocation to new calls*

When a user requests for a channel, the base station checks for its availability .If a channel is available, the base station calculates the CNIR of the particular channel in the cell. If the CNIR > threshold (δ) then the channel is assigned else checks for other channels. If no channel is available then the call is blocked.

D. *Channel re-allocation of ongoing calls*

When a user starts a call, it remains connected for some time. During this period, several events may occur affecting the communication between transmitter and receiver. Some of these events are: mobility of the transmitter, the emergence of other transmitters within the network, even the emergence of transmitters coming from other networks. All these events may degrade the quality of the communication channel. In order to avoid force termination, a channel re-allocation strategy is proposed. In this strategy, every user connected within every cell is evaluated. If interference condition is not satisfied, channel reallocation is implemented.

III. SIMULATION AND RESULTS

The main aim of the simulation is to study and compare DCA and FCA algorithm under various traffic patterns and user mobility in MATLAB. We have considered a cellular system of 19 cells of unit radius. In our case as shown in Fig. 4 the distribution of user in the system is random in nature. The user can be at any position in any cell. Every call request is subject to a Poisson process, with mean arrival rate λ = 6 calls per hour. The holding time is a random variable exponentially distributed with mean 1/µ = 120 s. To allocate and re-allocate channels the algorithm considers a CNIR threshold δ = 15 dB. As shown in the fig. 1, in every time period the following events take place:

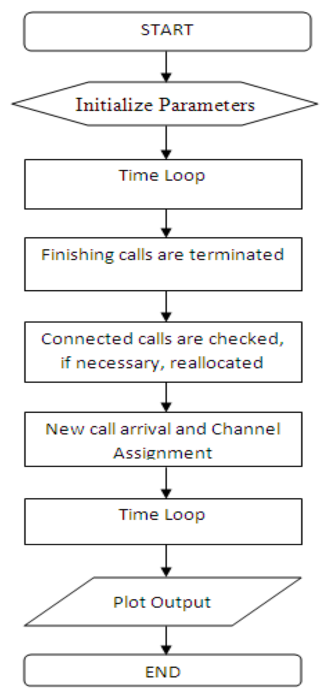

Fig. 1 : Main loop

A. Simulation of DCA

In the proposed work we have considered 19 channels for the system. Hence each cell in DCA can access 19 channels. Number of users varies from 200 to 1000. In each time period each user undergoes following events.

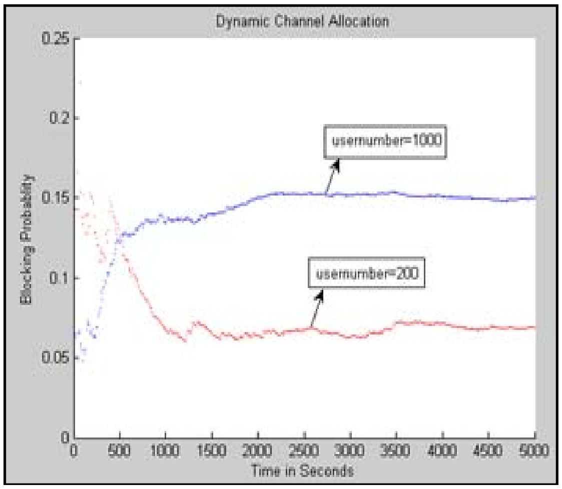

Fig. 2 : Transient response for DCA

a) Call termination: Calls of connected users are terminated if the holding time is completed.

b) Channel re-allocation: Calls of the still connected users are examined as given in [4]. They are re-allocated under following two conditions:

i) If the user has moved out of the cell (user mobility), the probability that the user moves out of the cell is considered to be 0.1. If the user moves out of the cell, then it moves into random surrounding cell to a random location in it. It checks whether a channel is available and calculates CNIR. If the CNIR > threshold (δ) then the channel is assigned, else force terminated.

ii) If the desirable interference condition is not satisfied then for every user we check if the CNIR> threshold (δ). If it is less than threshold it checks for other channels in the same cell which satisfies CNIR condition. If no such channel is available then it is force terminated.

c) Channel allocation: In every time period each user is checked whether he is connected, if not we check for available channels which satisfies CNIR condition. If no such channel is available then it is blocked as shown in (2).

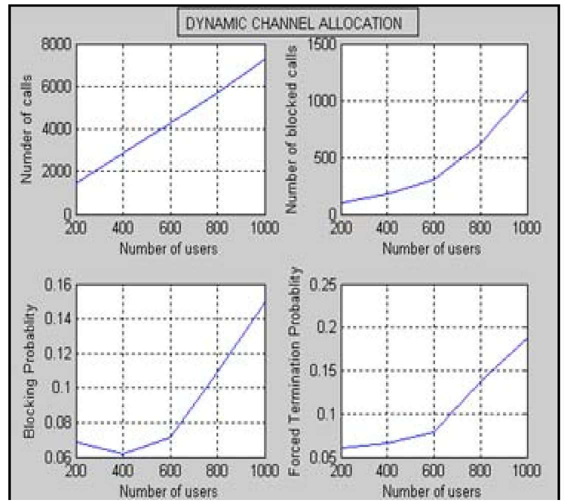

Fig. 3 : Parameters of DCA

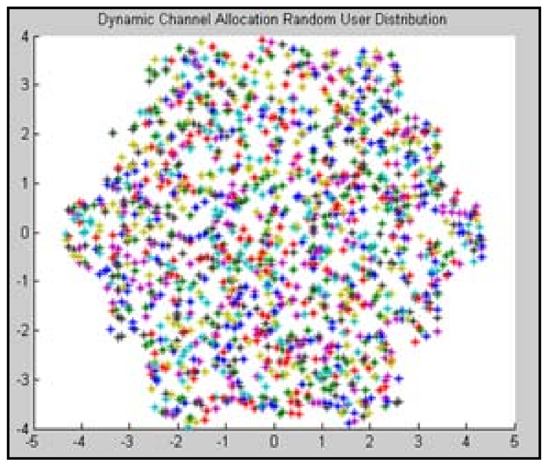

Fig. 4 : Random user distribution

B. Simulation of FCA

In the proposed work we have considered 19 channels for the system for simulation. Hence each cell in FCA can access only 1 channel because number of channels per cell is fixed. Number of users varies from 100 to 500. In each time period each user undergoes following events:

a) Call termination: Calls of connected users are terminated if the holding time is completed.

b) Channel re-allocation: Calls of the still connected users are examined. They are re-allocated under following two conditions:

i) If the user has moved out of the cell (user mobility), then it moves into random surrounding cell to a random location in it.

ii) If the desirable interference condition is not satisfied then for every user we check if the C/N> threshold (δ). If it is less than threshold it checks for other channels in the same cell which satisfies C/N condition. If no such channel is available then it is force terminated.

c) *Channel allocation:* In every time period each user is checked whether he is connected, if not we check for available channels which satisfies C/N condition. If no such channel is available then it is blocked.

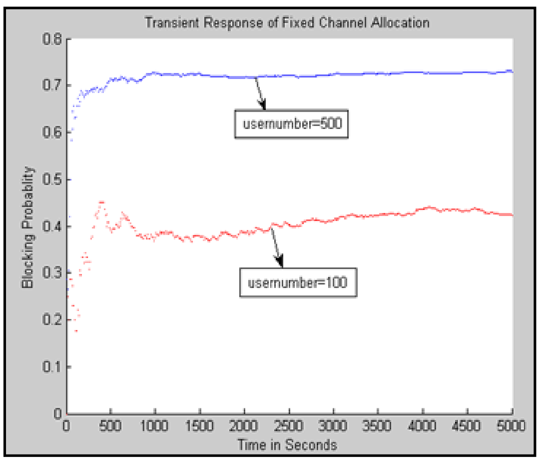

Fig. 5 Transient response for FCA

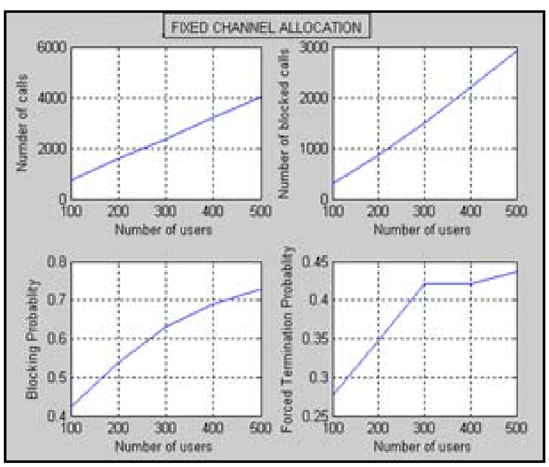

Fig. 6 : Parameters of FCA

C. Comparison between DCA and FCA

From fig. 2 and fig. 5 we can conclude that as number of users' increases blocking probability also increases. As seen from fig. 3 and fig. 6, for same number of channels the performance of DCA is much better than FCA. Number of blocked calls in DCA is far less than those in FCA and hence the blocking probability in DCA is much less than in FCA. The forced termination probability in DCA is less than that in FCA because of channel reuse. Hence DCA outperforms FCA in most parameters except for complexity. The formula in equation (2) evaluates theoretical value of blocking probability according to Engset's Loss formula [1].

$$P_b = \frac{\binom{M-1}{k}\rho^k}{\sum_{i=0}^{k}\binom{M-1}{i}\rho^i} \quad (2)$$

IV. CONCLUSION AND FUTURE WORK

The wireless resource allocation has received a tremendous attention due to rapidly growing interest in wireless communications. Spectral efficiency is playing an increasingly important role as future wireless communication systems will accommodate more and more users and high performance services. In this paper we have provided an extensive survey of the resource allocation problem in wireless communications and presented a detailed and comparative discussion of the major allocation schemes. With recent trends in micro-cellular networks and access-broadband networks where multimedia applications will be extended to end users using microwave links, we are faced with new, interesting and important challenges to the wireless resource allocation problem. These emerging new areas will introduce a new set of constraints in channel allocation problems. The solution to these problems will play an important role in providing ubiquitous access to multimedia applications in wireless networks.

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