Planning Wireless Code Division Multiple Access Network Considering Customer Traffic

Pavlina Hr. Koleva[1]

Abstract – **In this paper the behavior of the CDMA cell is investigated - using clustered Poisson process. The density function of the CDMA cell radius is modeled using the traffic intensity and the capacity of the cell. The investigations are done with singe cell.**

Keywords – **CDMA, Number of calls, Traffic intensity**

I. Introduction

Several system access methods are known from the references: FDMA, TDMA and CDMA. In an FDMA system, the time-frequency plane is divided into m discrete frequency channels. During any particular time, the user transmits signal energy in one of these m frequency channels with 100% duty cycle. In a TDMA system, the time-frequency plane is divided into m discrete timeslots. During any particular time, the user transmits signal energy in one of these timeslots with low duty cycle. In a CDMA system, the signal energy is continuously distributed throughout the entire time-frequency plane. The time-frequency plane is not divided among subscribers, as done in the FDMA and TDMA systems. Each end user employs a wideband coded signaling waveform. The technology that supports broadband wireless access to the end-users is WCDMA. It applies CDMA technique with broadened spectrum. This technology is applied in UMTS system.

II. Network Parameter Modeling

A cell in a CDMA network with Base Transceiver Station (BTS), witch supports a number of calls is considered -= Fig. 1. At the observation instant there are m calls to be supported and power-controlled in the cell.

Let us observe a subscriber i in conversation phase. This is the period of time, when the user transmits activity burst during his call. These bursts are separated by idle phases. The probability that the customer gets a link with acceptable Quality of Service (QoS) is a function of the distance to the base station and the current interference. The interference is not only depending on distance to base station x, but is also a function of the distribution of the calls currently supported in the cell.

This paper is an extension of the works presented in [2] and [3]. In [2] is investigated the blocking probability of a

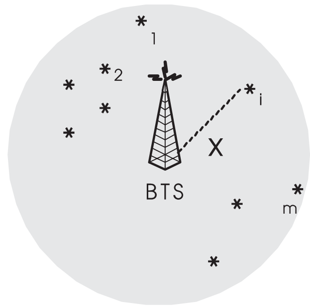

Fig. 1. CDMA cell with m supported calls

CDMA cellular system and the relation between dimension of the expanded frequency band and the number of users in the current cell (Erlang capacity). Also were made investigations when the frequency band is expanded/reduced twice and how this reflects on the number of served users. In [3] is investigated the blocking probability of the CDMA system while the data rate of mobile users are different. In bout works are taken into account the interference between users and interference between neighboring cells (multiple cells). But in bout cases is not taken into account the distance to the base station.

By modeling the location of the subscribers with spatial process, an analytic description of the user distribution within the cell could be obtained. A point process to characterize the relationship between number and location of the subscribers must be used. This paper deals with the homogeneous Poisson process.

III. Customer Traffic And Basic Relations

The distribution of the random variable M_A of calls on a surface with area A is Poisson distributed as:

$$P(M_A = m) = \frac{(\lambda A)^m}{m!} \exp(-\lambda A) \qquad (1)$$

where λ (in calls per km^2) denotes the spatial traffic intensity. The distribution of M_A given above is valid at any arbitrary observation instant.

Based on this Poisson process assumptions now consider a cell modeled by a circle with radius R_C. One active call is assumed to be on the circle and $m-1$ connections are inside the circle Fig. 1. The corresponding coverage area is $A = \pi R_C^2$, where both A and R_C are random variables. To give a precise analytic description the random variable A as the surface of the smallest circle containing m points must be defined [1,4]. Due to the property of the spatial Poisson

[1]Pavlina Hr. Koleva is with Telecom Department, Faculty of Communications and Communications Technologies at Technical University of Sofia, "Kliment Ochridsky" Blvd. 8, 1756 Sofia, Bulgaria, e-mail: p_koleva@vmei.acad.bg

process, the size of the surface A is distributed according to an Erlang-distribution of order m. It is more useful to consider the radius of the cell rather than its surface, as this can translate directly to the distance between subscriber and base station. The distribution of the radius R_C can be derived as:

$$R_C(x) = 1 - \sum_{i=0}^{m-1} \frac{(\lambda \pi x^2)^i}{i!} \exp(-\lambda \pi x^2). \qquad (2)$$

The probability density function is given by following equation:

$$r_C = \frac{\lambda(\lambda \pi x^2)^{m-1}}{(m-1)!} \exp(-\lambda \pi x^2)(2\pi x). \qquad (3)$$

With Eq. (3) the probability that we have a cell radius of x for a cell currently supporting m calls at an intensity of λ, could be calculated.

IV. Results and Analysis

Fig. 2 depicts the density function of the cell radius for different values on number of calls. The graphics are obtained using Eq. (3) with traffic intensity of $\lambda = 10$ [calls/km^2]. Plots for different values of number of users, an exactly $m = 10$, 20 and 30, are shown in the figure.

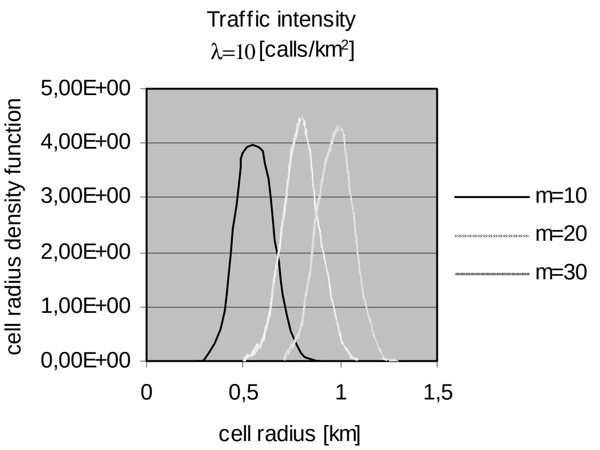

Fig. 2. Density function of the cell radius for different number of calls and $\lambda = 10$ [calls/km^2]

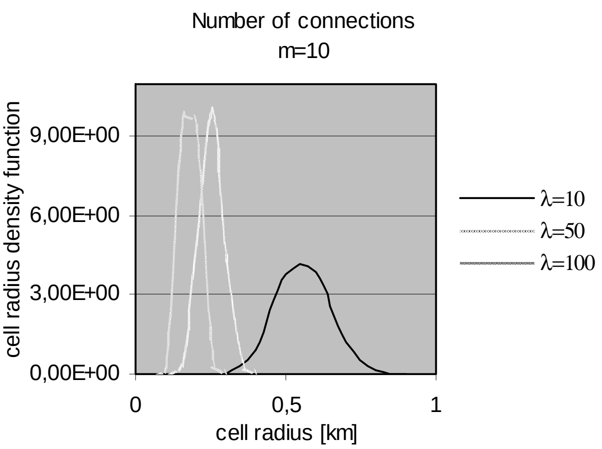

Fig. 3. Density function of the cell radius for different traffic intensity and $m = 10$

It shows that to support fewer calls, the mean cell radius is in general smaller than for larger values of number of calls, for fixed traffic intensity. The shape and variance of the cell radius density function for different m stay the same.

In the next graphic Fig. 3 are presented the curves for density function of the cell radius for different spatial traffic intensity. The value of calls number are fixed – $m = 10$. It indicates that for areas with high values of traffic intensity, e.g. urban or dense urban regions, the cell radius is more clearly defined than for areas with lower intensity, like the curve for $\lambda = 10$. The range of the radius is here more than double the size compared to traffic intensity $\lambda = 100$ [calls/km^2].

In Fig. 4 are shown the plots for density function of the cell radius for different values of calls number and for different values of traffic intensity. These values for number of calls are: $m = 10$, 20 and 30. The values for traffic intensity are: $\lambda = 10$, 50 and 100. From the curves on this figure it can be seen clearly what is the influence on traffic intensity and number of calls over cell radius.

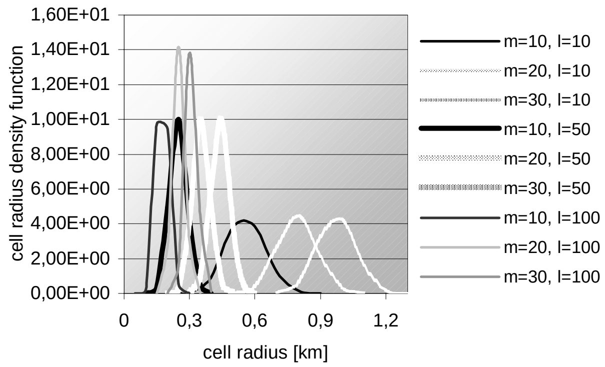

Fig. 4. Density function of the cell radius for different number of calls and different traffic intensity

V. Conclusion

An approach to obtain some relations about the influence of the number of calls and traffic intensity, over the cell radius is proposed in this work.

From the experiments and results that have been obtained it can be concluded that the augmentation of a number of calls lead to increase of the cell radius. An exact relationship is observed and when traffic intensity is increased. It is necessary to note that the investigations are made only for a singe cell.

References

[1] J. Sam Lee, L. Miller, “CDMA Systems Engineering Handbook”, 1998

[2] P. Koleva, G. Balabanov, “Teletraffic aspects of mobile ATM”, *ICEST’2002*, October 2002

[3] P. Koleva, Sl. Pavlova, “Teletraffic aspects in mobile ATM”, *TTONY’2002*, September 2002

[4] P. Tran-Gia, N. Jain, K. Leibnitz, “CDMA wireless network planning considering clustered spatial customer traffic”, *IT-NPS*, Italy, October 1998