Improving Handover Process In WCDMA System Using Umbrella Cell Technique

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الخلاصة

تعد السعة من أهم المتطلبات في النظام الخلوي والتي من أجلها يتم تطوير الأنظمة الخلوية . ولزيادة السعة في النظام الخلوي توجد أكثر من طريقة ومن ضمنها استخدام الخلايا الصغيرة (الخلايا المايكرو) في المناطق المزدحمة لكن هذه الطريقة تسبب مشكلة زيادة عدد المناقلات بالنسبة للمستخدمين ذوي السرعة العالية وبالتالي زيادة عدد المناقلات المصدة. من الممكن التقليل من عدد المناقلات باستخدام تقنية الخلية المظلية والتي هي عبارة عن خلية كبيرة (خلية ماكرو) تقوم بخدمة المستخدمين ذوي السرع العالية بالإضافة إلى الخلايا الصغيرة التي تخدم المستخدمين ذوي السرع البطيئة . في هذا البحث تم محاكاة نموذجين ، الأول دون استخدام الخلية المظلية والثاني بوجودها في نظام تعدد الوصول بتقسيم الشفرة عريض الحزمة باستخدام برامجيات (MATLAB) ومن خلال النتائج التي تم التوصل إليها تبين أن استخدام تقنية الخلية المظلية يحسن عملية المناقلة بشكل ملحوظ من ناحية تقليل عدد المناقلات وتقليل احتمالية صدها وتقليل عدد المناقلات المصدة بشكل كبير .

الكلمات المفتاحية

الخلايا الماكرو ، الخلايا المايكرو ، المناقلة المرنة ، الخلية المظلية ، نظام تعدد الوصول بتقسيم الشفرة عريضة الحزمة.

ABSTRACT

The capacity is an important requirement in the development of cellular systems. There are many methods to increase cellular system capacity such as using small cells (micro cell) in hotspot areas. This method increases the number of handovers for high speed users, which causes an increasing of the number of blocked handovers. It is possible to decrease the number of handovers by using umbrella cell technique. This technique uses large cell (macro cell) to serve high speed users and small cells to serve low speed users. In this paper, two models are simulated by using MATLAB program, with and without umbrella cell in Wide band Code Division Multiple Access (WCDMA) system. The results of this work show an improvement of the handover process by large reduction of the number of handovers, and decreasing the probability of blocked handovers in the case of umbrella cell technique compared to the other technique.

Key words

Macro Cell, Micro Cell, Soft Handover, Umbrella Cell, WCDMA.

1. Introduction

Handover or handoff can be defined in mobile telecommunications, as the process of transferring an ongoing call or data session from one channel (Frequency, time slot, code) connected to the core network (base station, BS) to another channel [1,2].

Youghuanetal. in [3] have studied the features of cellular engineering in Code Division Multiple Access (CDMA) system with soft handover process and distinguished the control area of the cell from the cell coverage area. They built a Markov chain model for continuous time in a (CDMA) system with queue for the soft handover process. The numerical results showed the effectiveness of the proposed Markov chain models.

Sami et al. in [4], propose a way to select the macro / micro channels in the cellular system using the time to stay in overlap area of the micro cells and study the change of the number of channels in micro cells in the macro cell with a blocking probability for different speed of Mobile Station (MS).

Cheng et al. in [5], have studied a new strategy for the handover to improve mobile network performance by reducing the handover blocking probability using delay new call requests technique for a period of time. They used the channels in the handover process and chose the best time period, in order not to affect the blocking probability of new calls.

The increase in the demand for mobile communications has led to make small cells in hotspot (crowed) area more popular than large cells to it is the increase the number of channels per unit area, that leads to an increase in the number of users (increasing capacity). This causes an increase the probability of a handover process, especially for users with high-speed so a new challenge arises due to the development of handover process technology to ensure that no failure in communication (handover blocking) while the user moves from cell to other. Umbrella cell technology is one of these new technologies [6].

2. Theoretical Fundamentals

Direct Sequence Code Division Multiple Access (DS-CDMA), with information signals spreaded on wideband of (5MHz), is called Wideband Code Division Multiple Access (WCDMA). The adoption of the third generation (3G) systems for (WCDMA) technology is to transfer information with high speed and greater flexibility in the provision of multiple services for one user [7,8].

The 3G cellular system uses micro cells in crowded areas to increase capacity in addition to soft handover (called make-before-break)[8]. It means that the user will get more than one channel in the handover area. After leaving the handover area takes the channel of the cell in which it entered [9 -12].

2.1.Umbrella Cell

A large cell which is used to cover the geographical area, leads to reducing the number of handovers. In contrast, this large cell has a number of disadvantages such as [6]:

(1) Requiring high transmit power.

(2) Reducing the battery life because it sends a high signal power when they are far away from

the base station.

(3) The number of channels is limited in the system.

On the other hand, small cells that serve well a geographical area have many advantages, such as [6]:

(1) Low transmission power.

(2) High capacity.

(3) Maintain battery period of life and the power of MS.

The main disadvantage of small cells, is producing a large number of handovers, which affect the system capacity because a single user may be using more than one channel at the handover moment, especially users with high speed as illustrated in Fig.(1).

For the above, the umbrella cell method is developed, which is a hybrid system composed by small cells inside one large cell. Large cell is called an umbrella cell as described in Fig.(2), where is allocated a number of channels to the base station of umbrella cell [13].

The most important feature of this method is to reduce the handovers to the user with a high speed. User's handover is controlled by changing the call to the umbrella cell, resulting in decreasing the number of handovers. A user that passes many small cells, may not come out of the umbrella cell borders during the communication [14]. The high transmitted power in the umbrella cell is a disadvantage, but on the other hand, there are a number of advantages, including:

(1) Increasing the number of available channels.

(2) Good service for users (call continues without cutting).

(3) Maintaining age of mobile battery of low speed users.

In the umbrella cell technique, the BS at any cell uses the process in flow charts as shown in Figs. (3) and (4) to handle the two types of requests (new call and handover).

2.2. Simulation

MATLAB software (version 7.10) is used as the simulation program to represent a WCDMA cellular system in two models. The first model is a system without using the umbrella cell as illustrated in Fig. (5). The second system shown in Fig. (6) uses the umbrella cell. Macro cell radius is (6000)m while micro cell radius is (2000)m.

Users distributed uniformly in both models, were direction and speed of each user are generated, and the direction is updated periodically. Each cell in the first model is allocated 20 channels, while in the second model, each micro cell gives (4) channels for the umbrella cell (macro) while the remaining (16) channels is allocated to each micro cell. Thus, the number of channels in the umbrella cell will be as in the following equation:

$$C_{Umb} = 4N \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where:

C_{Umb}: is the number of umbrella cell channels.

N: is the number of micro cells covered by umbrella cell.

Call time follows an exponential distribution with holding time (180) sec. The number of calls during the simulation period depends on the traffic load, which could be calculated from the following equation [11]:

$$\text{Traffic load} = \frac{\lambda H}{C} \quad \dots\dots\dots\dots\dots\dots \quad (2)$$

where:

λ: the number of incoming calls to a cell at one hour.

H: time rate for calls.

C: The number of channels in the cell.

During the simulation (the duration is 6 hours), the location of each mobile station is tracked periodically every one second, with the assumption that the location measurement is located by GPS system. Users speed can be evaluated by taking more than one reading of the location, then by dividing distance over time. the user's speed can be known then ,that is whether it is equal to one or more than the critical speed.

The handover request is presented after the arrival of MS to soft handover area, which is defined as the ratio of the handover area to the total area of the cell [10]. If there is a free channel, the handover process will be succeeded, if not, the request will be blocked.

To increase the accuracy of the simulation results, the average of (25) implementations for each model are simulated. Table (1) and Table (2) illustrate the factors used in the simulation.

3. Results and discussion

The models are applied for different values of traffic load, then evaluating the average number of handovers, the percentage of handover blocking probability, and the average number of blocked handovers for the purpose of comparison between the two models, and to find out the improvement in the handover process for the second model (which uses the umbrella cell).

Fig. (7) shows the relationship between the number of handovers with the radius of the cell when the load is (100%). Increasing the radius of the cell, will reduce the number of handovers, due to the fact that high speed users may leave more than one small cell during one call, therefore more than one handover is needed. While large cells require fewer handovers during one call or may be without need to handover. For this feature umbrella cell is used with a radius relatively large compared to the rest of the cells in the system.

Fig. (8) illustrate the relationship between the average number of handovers and traffic load for first and second models respectively. This Fig. show that the number of handovers increased directly proportional to the load change, but it will be less in the second model. In the first model, the number of handovers tarts from (102) handovers at traffic load of (10%) to (955) handovers when the traffic load is 100%, caused by the increase user numbers in overload traffic. The second model shows a large decrease in the number of handovers observed in comparison with the first model. With traffic load of 10%, the number of handover is (69), and nearly (641) handovers when traffic load is 100%, the number of handovers is reduced by approximately (33%) from the first model. Handovers decrease for the second model is resulting from the high speed users who are served by the large umbrella cell, therefore a fewer numbers of handovers are needed.

Fig. (9) illustrates the relationship between the average percentage of the handover blocking probability and the traffic load for the two models. First curve represents the result of the first model, shows that when the traffic load increases , the handover blocking probability will increase, starting from very low values and then rising to become almost (1.559%) when the traffic load of (100%). Second curve shows the result of the second model for the handover blocking probability increased with the increase of traffic load as well but they are less than the first model, reaching approximately 1.358% when traffic load of (100%).

Comparing Fig. (10), which represents the relationship between the average number of blocked handovers and traffic load, shows the improvement in the handover process in the second model. The number of blocked handovers is small for the two models at low traffic loads, but for high traffic load, the number of blocked handovers will be increased. For example 90% of traffic load produces (6) blocked handovers for first model, and (3) for the second model. With load of (100%), there are more than (15) blocked handovers for first model and less than (8) blocked handovers for the second model. This result means that when the umbrella cell technique is used, the improvement in reducing the number of blocked handover is approximately (50%) of the number of blocked handover in the first model which does not use the umbrella cell.

4. Conclusions

Comparing the first model (without using the umbrella cell) that contains micro cells only with the second model (without using the umbrella cell) which contains in addition the umbrella cell, results show an improvement in the handover process in terms of reducing the number of handovers by approximately (33%). The probability of handover blocking is reduced from (1.559%) to (1.358%) for the same traffic load. The difference between the two values is small, but the difference is that the number of handovers in the second model is less than of that in the first model. Therefore, the number of blocked handovers is reduced by (50%) in the second model.

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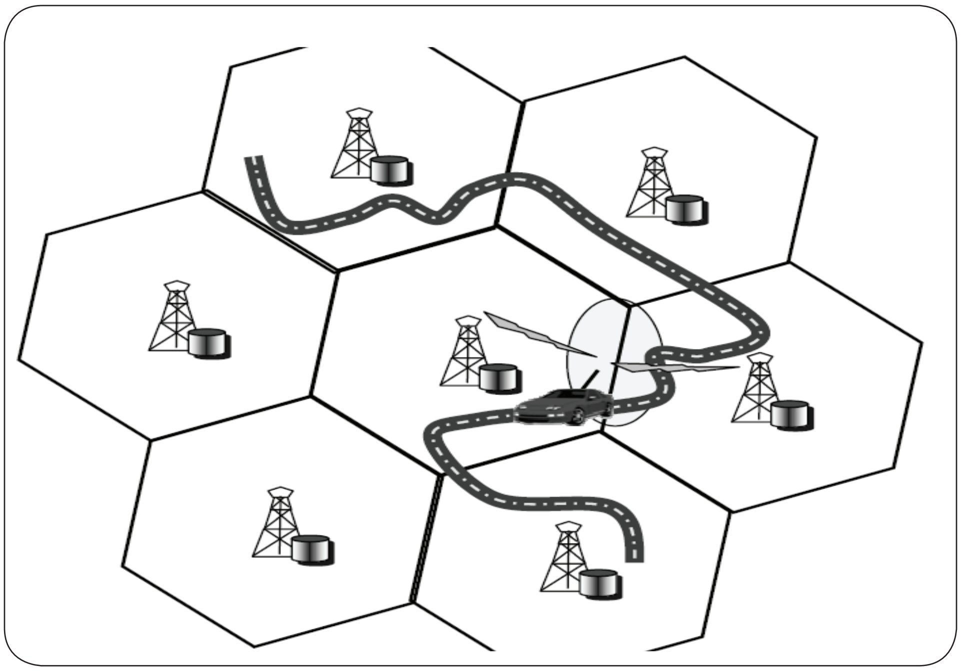

Fig. (1): High speed user [2].

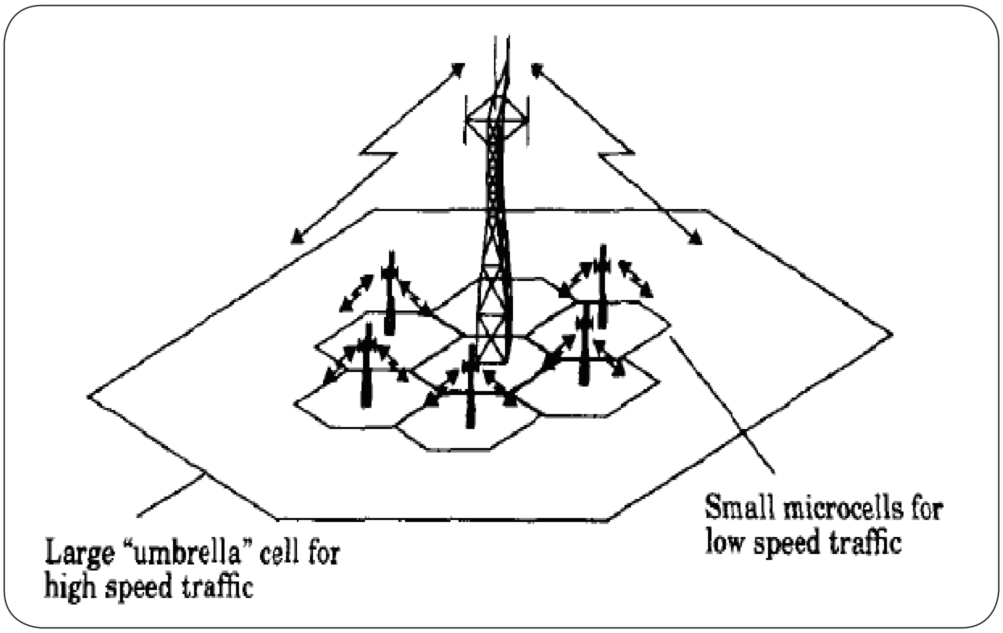

Fig. (2): Umbrella cell [13].

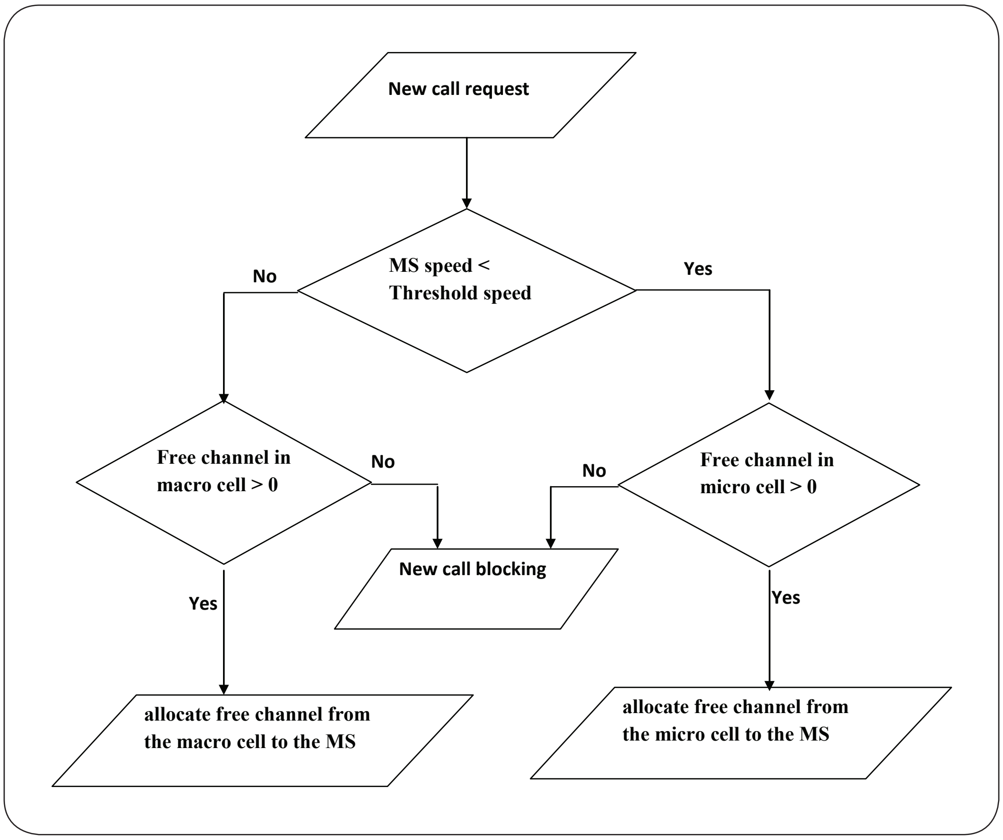

Fig. (3): Flow chart of new call in umbrella cell.

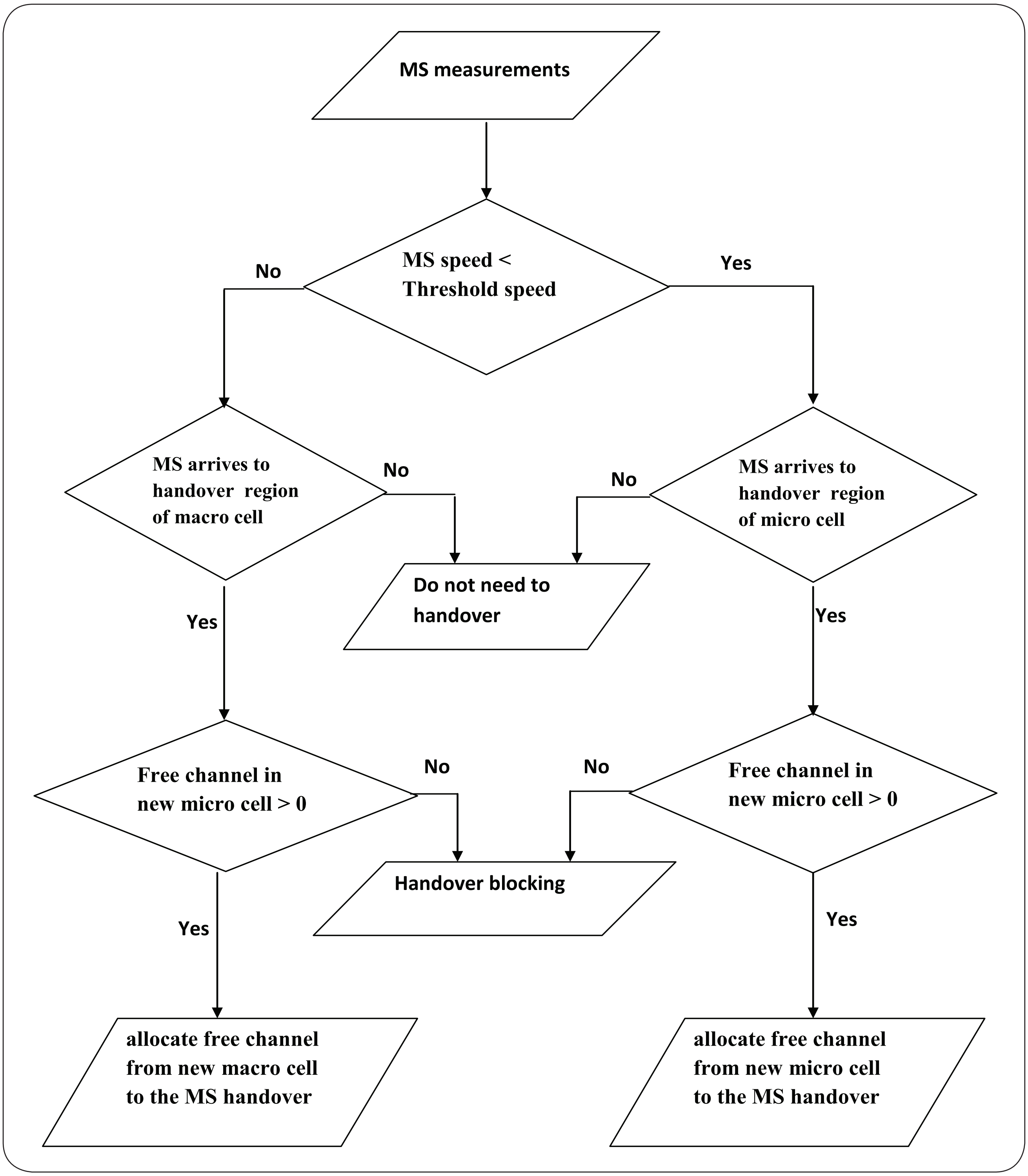

Fig. (4): Flow chart of handover in umbrella cell.

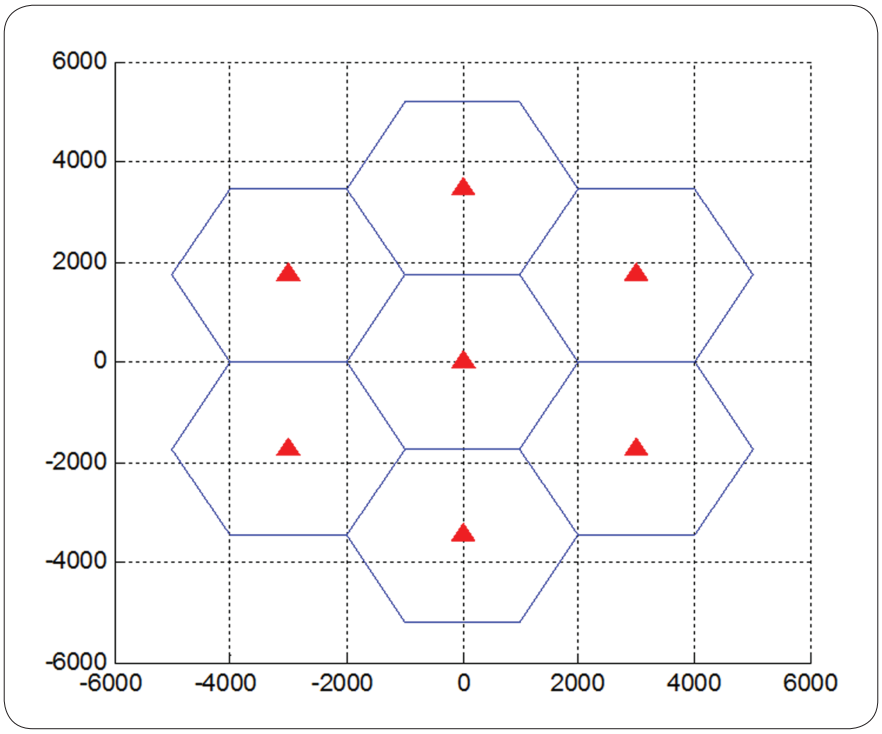

Fig. (5): first model cells.

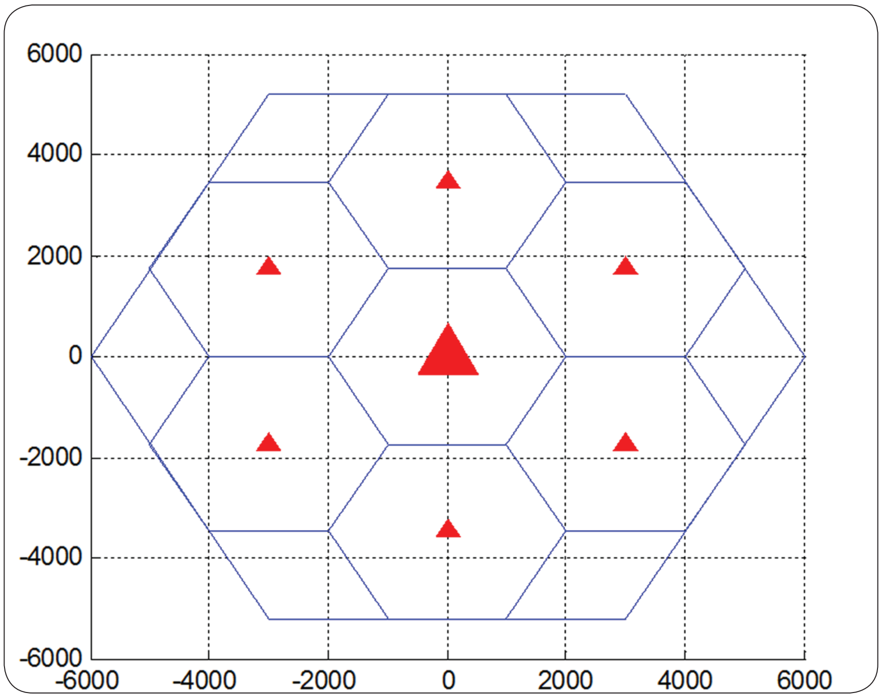

Fig. (6): second model cells.

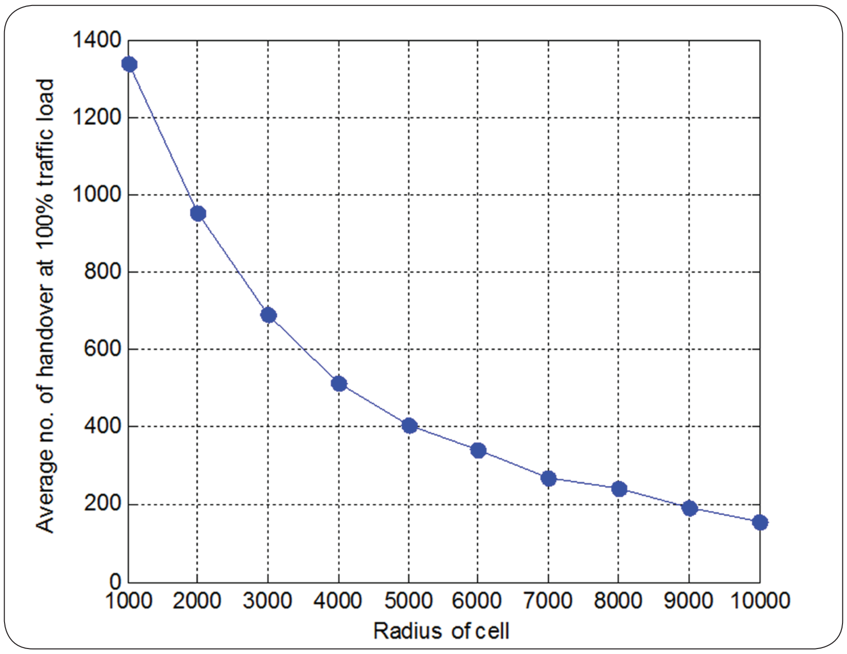

Fig. (7): avaerage number of handovers with radius of cell at 100% traffic load.

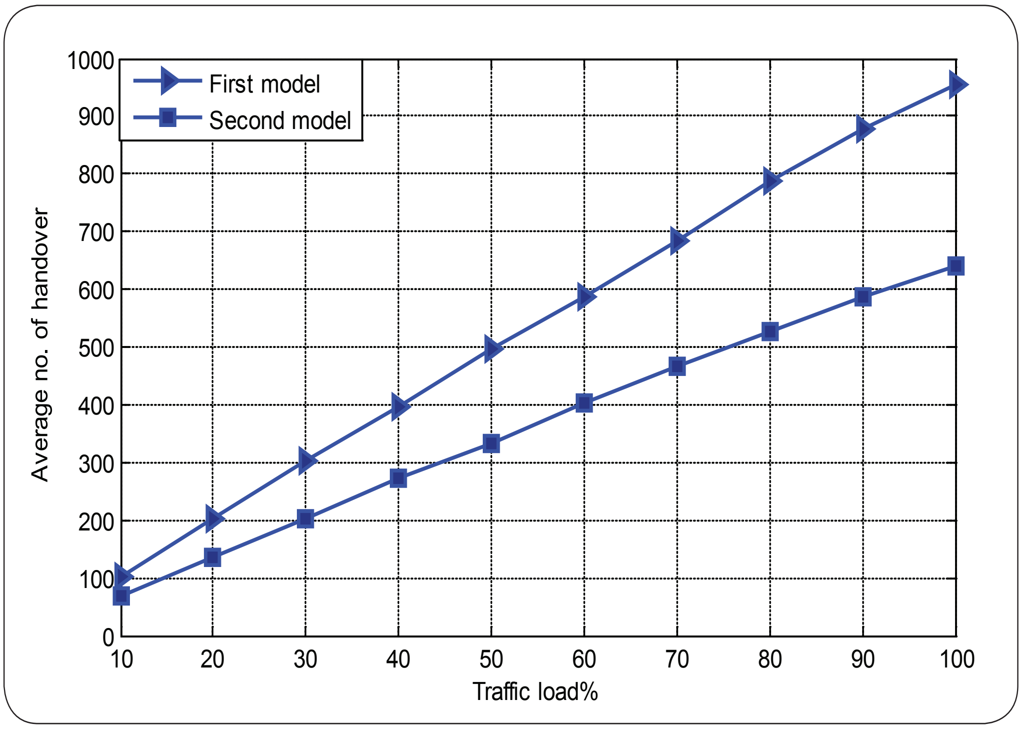

Fig. (8) : Average number of handover with traffic load.

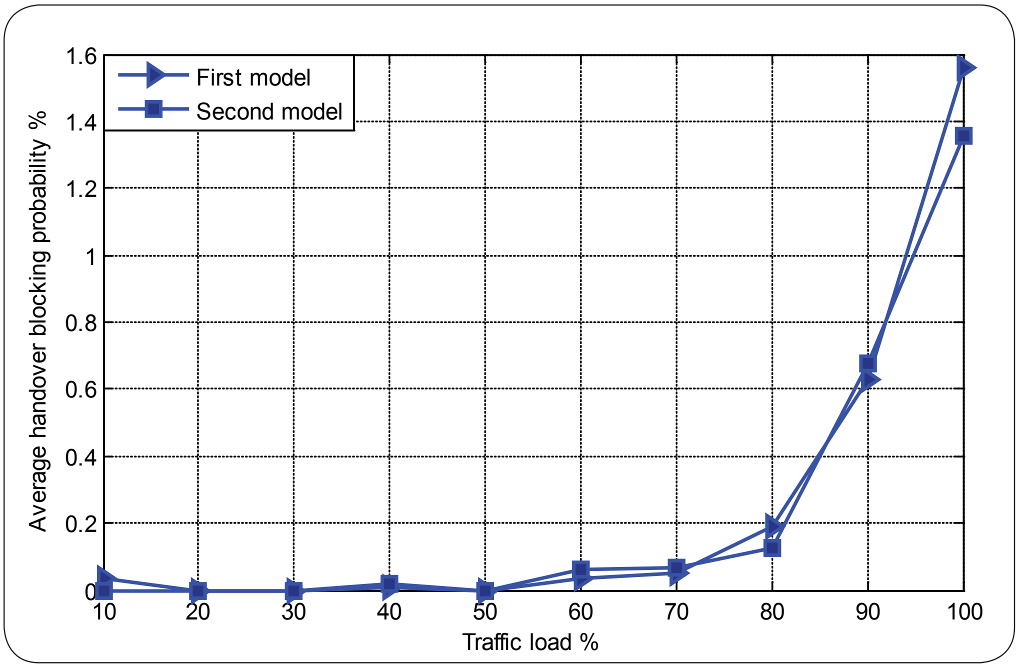

Fig. (9) : Average percentage blocking probability with traffic load.

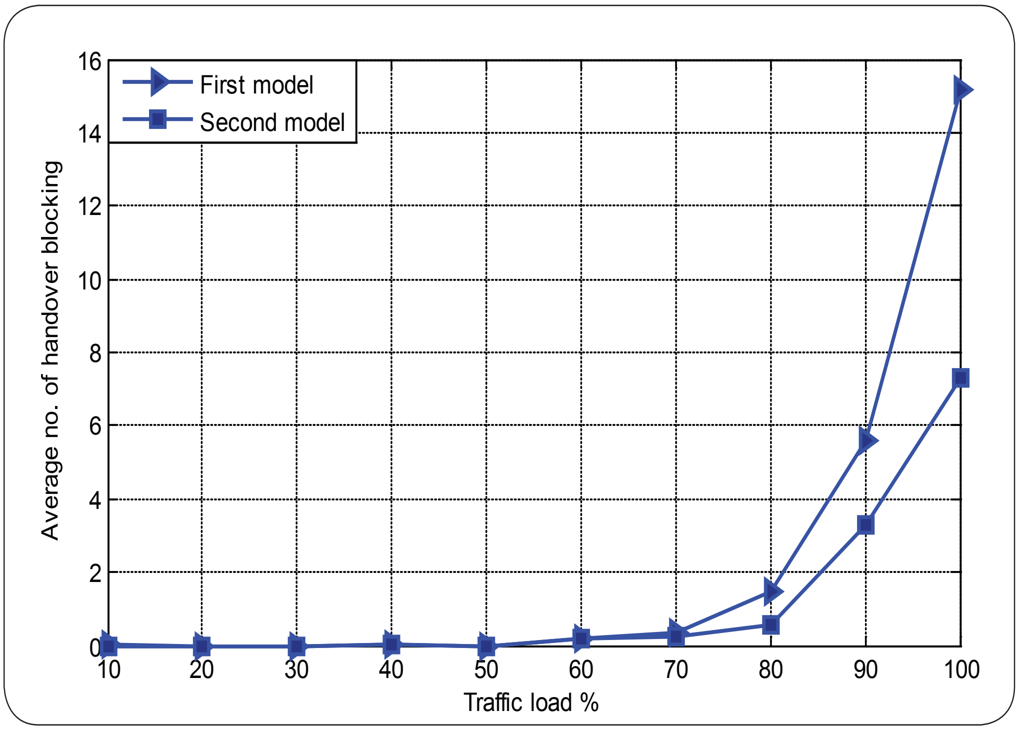

Fig. (10): Average number of blocked handover with traffic load.

Table (1): Simulation Factors

Factor	Value
Cell radius	2000m
Number of channels in cell	20
Users speed	m/s [0-20]
Soft handoff area	15%
Duration of simulation	h 6
Number of simulation runs	25
Holding time	s 180

Table (2): Umbrella cell factors

Factor	value
Cell radius	6000m
Number of channels in micro cell	16
Critical speed	m/s 16