International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 1540–1556

Extension of Handoff with The Help of Wider Channels

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Abstract

In this paper, we have discussed the issue of the IEEE 802.11 Wireless Local Area Networks (WLAN) based wireless blocking probability with its algorithm and upgrading of the channels. WLAN provides multimedia services like live telecast, video streaming, video conferencing, Voice over IP (VoIP) to its users. For deployment of these fast real time services, it needs stringent Quality of service (QoS) requirement such as delay time less than 150ms for VoIP, and packet loss rate of 1% . The user mobility service provides the handoff cost required when mobile stations are linked for continuous service from one access point (AP). In existing 802.11 IEEE handoff procedure, the scanning phase can exceed duration of 200ms and packet loss can exceed 10%. Through the implementation of handoff time of less than 150ms the proposed approach focuses on achieving reduced general handoff latency, which in IEEE 802.11 is sufficient for seamless operation.

Keywords: *BS (Base Station), MN (Mobile Node), RSS (Received Signal Strength), WLAN (Wireless Local Area Network),AP (Access Point)*

1.Introduction:

It has been expanded to personal and business purposes by IEEE 802.11 built from wireless local area networks (WLAN). The networks are used for Voice over IP (VoIP) handoff latency management and multimedia are some pricey applications for smooth and continuous handover in Quality of Service (QoS).

1.1 IEEE802.11x Architecture

Types of Wireless LAN: The operating modes of IEEE 802.11 are two basic modes: infrastructure and ad hoc modes. Mobile units directly relay peer-to - peer in ad hoc mode. mobile units connect in networking mode as a connector to other networks (such as the Internet or the LAN) through an access point.

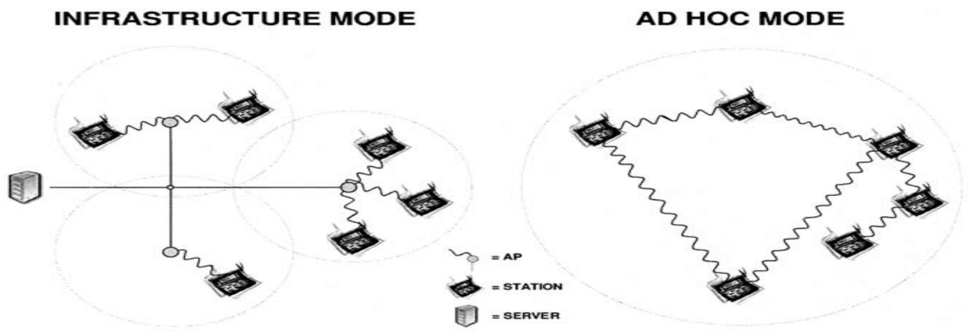

Fig 1. Types of wireless LAN: Infrastructure Mode and AD Hoc Mode

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1.2 Handoff:

A handoff means the transmission from one cell into another or from one channel in a cell into a cell in another. The handoff refers to the transmission process. For the provision of continuous service to a caller or data session user a well implemented handoff is essential. Cellular networks are made up of cells that can each serve subscribers wandering inside of their cells. Only a certain area and number of subscribers can be covered by each cell. Therefore a handoff occurs when one of those two limits has been reached.

1.3 Handoff and its different types:

1.3.1. Hard Handoff: Characterized by a true disruption of the relation between cells or bases. The transition is so quick that it is hard for the user to note. Services that permit little delay, such as mobile broadband Internet, are also necessary. This is normally a handoff between frequencies. It's "breaks before make " policy .

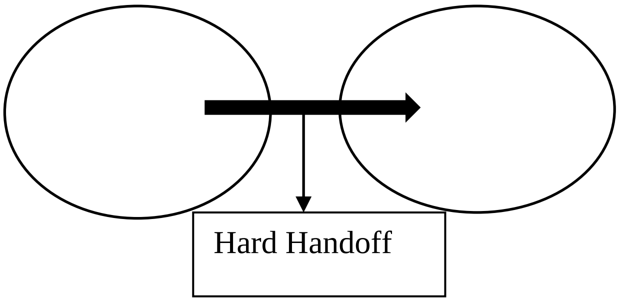

Fig 2: Hard Handoff

1.3.2. Soft Handoff: Two cellphone connexions from two different base stations are provided. So during the handoff, no break occurs. In general, this is used in places co-located. It's a strategy "make before breaking."

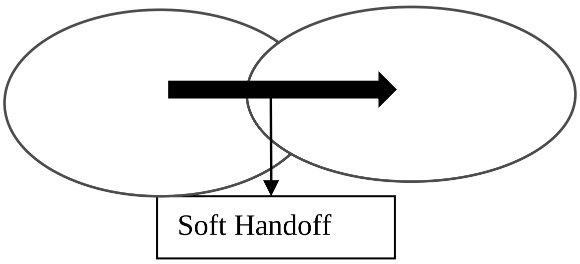

Fig 3: Soft Handoff

2. Related Works

A variety of investigators have been engaged in improving the performance of heterogeneous wireless networks in the next decade. Recently a variety of protocols and algorithms for smooth handoff in NGWS have been proposed(Amer, 2013).

(Youghuan et al.) Studying cellular engineering characteristics in a soft handover system (CDMA) Code Division, and distinguishing between cell control zone and cell coverage area. For continuous time, they constructed a Markov chain model in a (CDMA) system with a soft transfer queue. The results showed the efficiency of the chain models proposed by Markov.

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(Sami et al., 2010) Propose how to use the time to remain overlapping in the micro-cell region in the cellular system for macro-/ micro-chain selecting and testing a shift in the number of channels in the macro cell at different speeds of the Mobile Station (MS).

(Kim et al., 2004) 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.

As demand for mobile communications increased, it made small cells more common in hotspot (crowded) than large cells, which contributes to an increase in the number of channels in each unit area (increasing capacities). This increases the likelihood of a transfer operation, especially for high-speed users. Thus, a new challenge emerges when the operation technology evolves to ensure that contact (transmission blocking) does not fail as the user transfers from cell to cell. One of these emerging innovations is umbrella cell technology.(Stemm et al., 1998)

The (DS-CDMA) Direct Secuence Code Division Multiple-Access is called the WideBand Code Division Multi-Access (WCDMA) with information signals scattered through broadband (5MHz). The implementation of 3G systems for (WCDMA) technology is to provide high-speed, versatile transmission of information in multiple consumer services. (Mishra et al., Mohanty et al & Akyildiz, 2006).

The 3G cellular system uses micro cells in crowded areas to increase capacity in addition to soft handover (called make-before-break)(Brannstorm et al., 2006) . 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 (Albonda & Yousef, 2015) (Mawjoud & Fasola, 2011).

In a handoff algorithm using distance measurement method is used where the distance of MN from each BS is calculated and by comparing them the best neighbor AP can be found out. (Rappaport, 2002)

3. Proposed Works

In this paper we suggest a handoff management protocol for the smooth handling of wireless systems of next century. We consider the speed of the mobile node, the Umbrella Cell, the base station relative signal power, delay information handoff and the likelihood of initiation threshold distance from cellular boundary handoff which creates undeficient traffic load and sometimes call blocking.

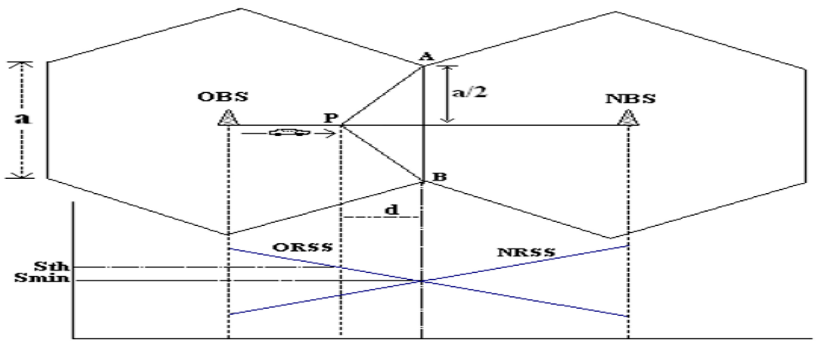

Fig 4: Handoff scenario between OBS and NBS.

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We regard the Base Services (BS) coverage area as standard hexagonal cells for our proposed work. We take into consideration two baselines, one being OBS, where the call is produced and the other being NBS, the next destination for the MN. If the OBS coverage area appears to be moved out of the MN, NBS is needed for further calling. Figure 4 explains the OBS-NBS handoff situation. The following parameters are described in Figure 4.

S_{th} = The threshold value of the RSS to initiate the handoff process. When the RSS of old BS (OBS) referred to as ORSS drops below S_{th} the MN starts the HMIP registration procedures for handoff to new BS (NBS).

S_{min} = The minimum value of RSS required for successful communication between the MN and OBS.

a =The cell size.

d = The threshold distance from cell (OBS) boundary, where the MN starts HMIP registration.

We divide our proposed work into five sections:

3.1. Speed Estimation.

3.2. Measurement of threshold distance d from the cell (OBS) boundary.

3.3. RSS and S_{th} Measurement.

3.4. Handoff Management.

3.5. Umbrella Cell.

3.1 Speed Estimation.

The speed of the MN is estimated by using the Doppler Effect. The received signal frequency and the carrier signal frequency and the speed of the MN are respectively f_r , f_c , and v_m . And Vc is speed of the light. Hence

$$f_r = \frac{(v_c - v_m cos\theta)}{v_c} . f_c \text{..................... (1)}$$

$$or, \quad f_r / f_c = \left(1 - \frac{v_m}{v_c} . cos\theta\right)$$

$$or, \quad v_m = \frac{(f_c - f_r)}{f_c} . sec\theta$$

$$or, \quad v_m = \left(1 - \frac{f_r}{f_c}\right) . v_c sec\theta$$

This equation helps to estimate the speed of the MN.

When the MN moves out of the coverage area of OBS through radial outward direction,

sec θ = 1.

Thus $$v_m = \left(1 - \frac{f_r}{f_c}\right) . v_c \text{..................... (2)}$$

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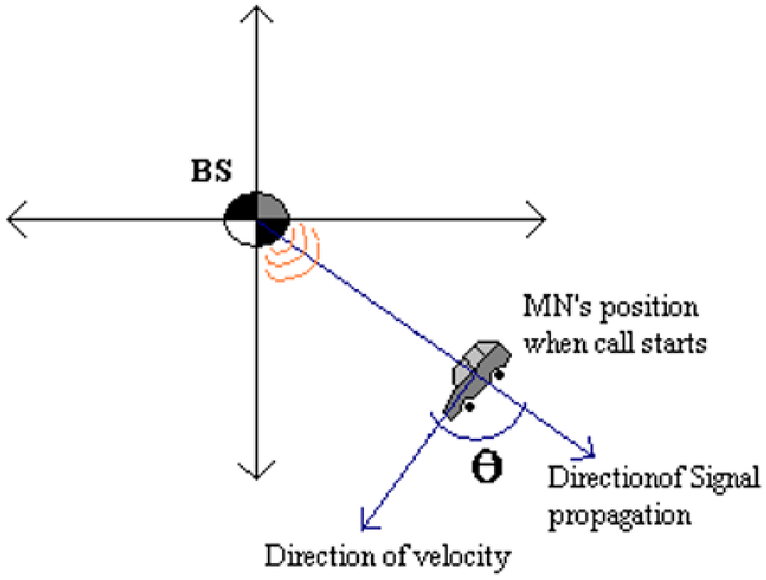

Fig 5: Measurement of threshold distance d

3.2 Measurement of threshold distance d from the cell (OBS) boundary

3.2.1. Case 1: Let handoff signaling delay is Γ, when the MN moves out of the coverage area of OBS through radically outward (Figure.5) direction the MN needs to initiate HMIP registration at the distance d from the cell boundary for a successful handoff. Otherwise the MN does not get enough time to complete the total handoff procedure.

So for a successful handoff (handoff success probability maximum) in this case

$$d \leq \Gamma . v_m \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

3.2.2. Case 2: When the MN reaches the point P, the RSS starts to drop below the $\mathbf{S_{th}}$ value. Here the MN needs to initiate HMIP registration. Now the MN can move to any direction from P with equal probability. For a worst case if MN moves out through PA or PB (Figure. 4), it remains within the $\mathbf{S_{th}}$ region and overlap region of OBS and NBS. So the MN can initiate handoff without any hesitation from here. In this case

$$PA=PB=\sqrt{(a/2)^2 + d^2}$$

For handoff

$$\Gamma < \frac{\sqrt{(a/2)^2 + d^2}}{v_m}$$

$$or, \; d > \sqrt{(\Gamma . v_m)^2 - a^2/4} \; \ldots\ldots\ldots\ldots (4)$$

In this case handoff failure probability is maximum. Combining (3) and (4) we get,

$$\sqrt{(\Gamma . v_m)^2 - a^2/4} < d \leq \Gamma . v_m \ldots\ldots\ldots\ldots\ldots (5)$$

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For this condition handoff success probability lies between zero to one.

3.3 RSS and S_{th} Measurement

The OBS antenna is transmitting a signal which gets weaker as The MN moves away from it. The transmitted signal power is maximum at the centre of the cell and gradually decreases as the distance from the centre increases. The received signal strength (RSS) at a distance **x** is given by

$$P_r = \frac{G_r.G_t.P_t}{(\frac{4\Pi x}{\lambda})^2} \quad (6)$$

λ=wave length of the transmitting signal.

G_r= Receiving antenna gain.

G_t= Transmitting antenna gain.

P_t=Transmitting power.

The threshold value of the received signal strength,

$$S_{th} = \frac{G_r.G_t.P_t}{(\frac{4\Pi y}{\lambda})^2} \quad (7)$$

Where $y = (\frac{\sqrt{3}}{2} a - d)$

And $d = \Gamma . v_m$

We take this value as we calculate the limiting value for d previously. After this distance the MN can starts handoff initiation. After call setup the MN periodically checks the RSS, when RSS drops below the calculated threshold value the MN tries to initiate HMIP registration.

The wave propagation in multipath channel depends on the actual environment, including factors such as the antenna height, profiles of buildings, roads and geo-morphological conditions (hills, terrains) etc.

These factors cause propagation loss in the channel. Hence the received signal strength may be

$$P_r = \frac{G_r . G_t . P_t}{L}$$

Propagation loss L is characterized by three aspects: path loss (**L_p**), slow fading (**L_s**) and fast fading (**L_f**).

$$L = L_p.L_s.L_f$$

In a typical urban area propagation loss is measured as (Mawjoud & Fasola, 2011)

$$L_{pu}(dB) = 69.55 + 26.16 \log_{10} f_c(MHz) - 13.82 \log_{10} h_b(m) - \alpha[h_m(m)] + [44.9 - 6.55 \log_{10} h_b(m)] \log_{10} x(km)$$

h_b= Base antenna height

h_m=MN's antenna height

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x =Distance of MN from the BS. This can be calculated easily. By using Neighbor Graph, the position of MS (x_m,y_m) and the position of BS (x_b,y_b) can be found out and from these two coordinate we can calculate the distance of MS from BS. So, the distance is:

$$X=\sqrt{\{(x_b - x_m)^2 + (y_b - y_m)^2\}}$$

$\alpha[h_m(m)]$ =correlation factor for the MN's antenna height. Where,

$$\alpha[h_m(m)] = [1.1 \log_{10} f_c - 0.7]h_m(m) - [1.56\log_{10} f_c - 0.8]$$

3.4 Handoff Management

Handoff Initiation: The MN's first challenge is to determine the best time to start HMIP registration when it goes off its old BS. The handoff trigger unit (Figure 5) estimates the MN speed and its direction and signals to assess the RSS (Sth) threshold. The handoff trigger unit sends a handoff request to a handoff execution unit when the RSS falls under Sth to initiate the HMIP handoff.

Handoff Execution: The MN begins HMIP registration after the receipt of the request for handoff from the handoff trigger device. The MN is transferred to the new BS once it has been done. For a certain time, the MN retains its HMIP registration with its old BS. This is carried out by the simultaneous HMIP protocol binding method. In case of intra-system transition, and inter-system transmission to the intra-system handover, the MN connects the address care (CoA) of the old foreign agent (OFA) and the new FA (NFA). Therefore, during this time period, the GFA and HA forward paquets for the MN for both CoAs. It may be noted that for an inter system handoff these two CoAs may belong to two different network interfaces when the MN moves between networks of different wireless technologies. Therefore multiple interfaces of the MN can be used to reduce the ping-pong effect during an inter system handoff.

3.5 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:

(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:

(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 Figure:(6).

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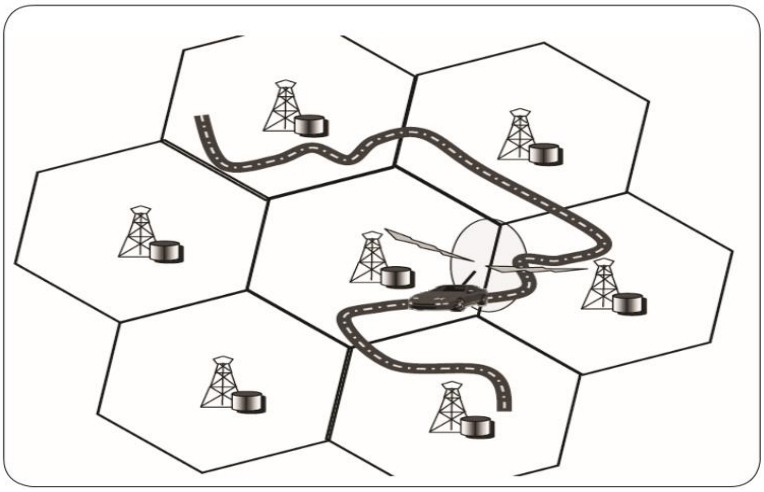

Fig 6: High Speed User.

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 Figure.(7), where is allocated a number of channels to the BS of umbrella cell.

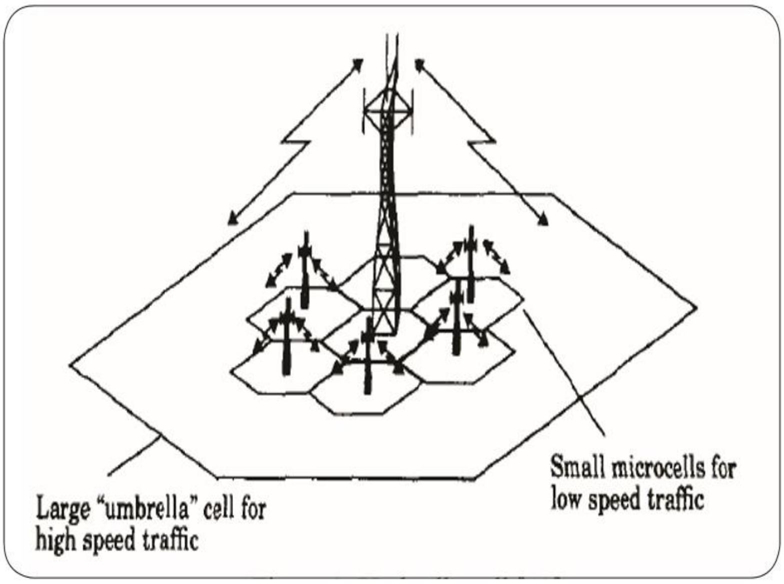

Fig 7: Umbrella Cell

The main advantage of this approach is that high speed transfers are reduced to the user. The move of the user to the umbrella cell is regulated by changing the call, which reduces the number of transfers. A consumer who moves through several small cells can not come out during the contact from the umbrella cell boundaries. The high power transmission in the umbrella cell is a drawback, but there are many benefits on the other hand, 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 Figures. (8) and (9) to handle the two types of requests (new call and handover)

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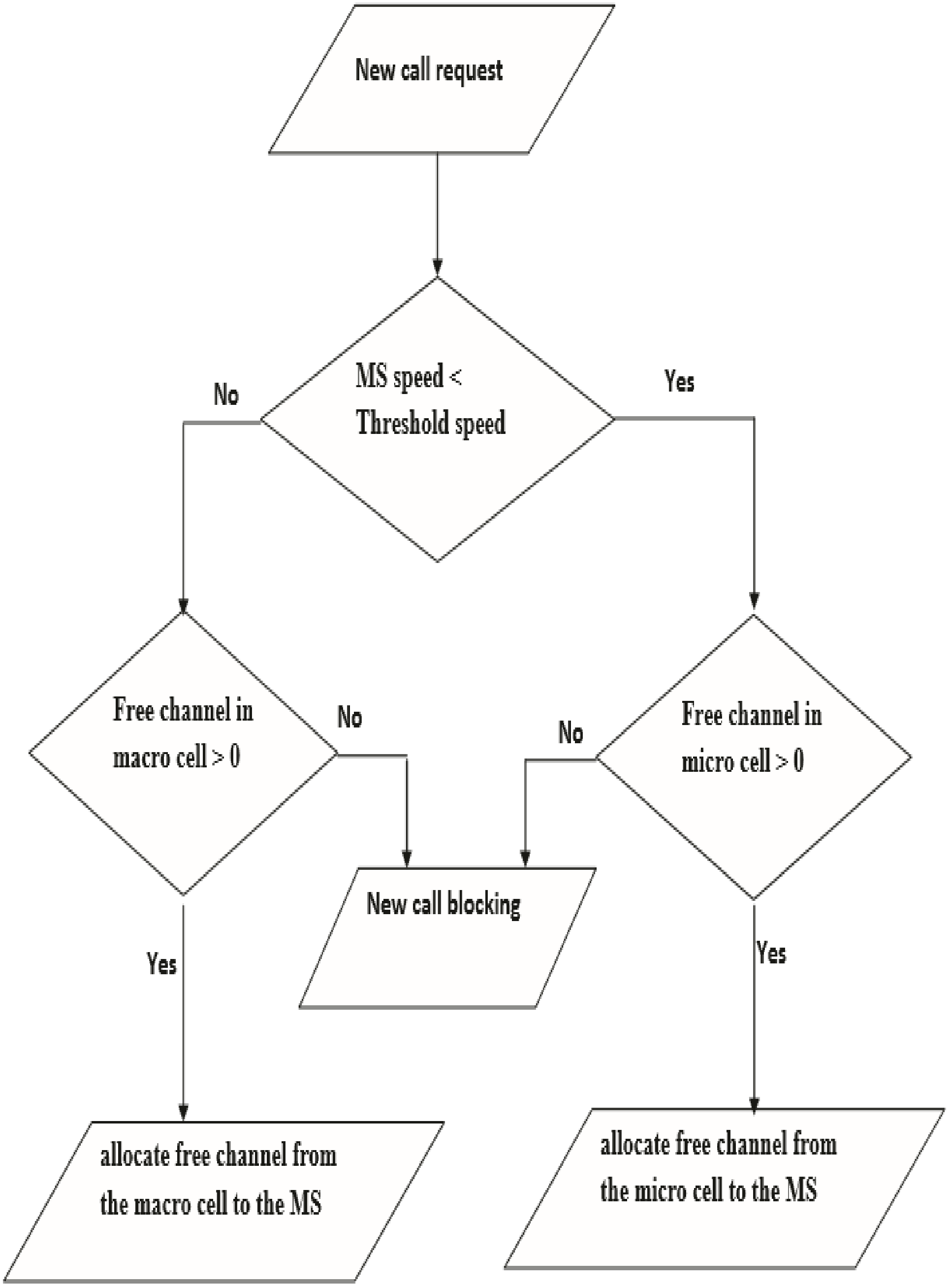

Figure 8: Flow Chart of new call in Umbrella Cell.

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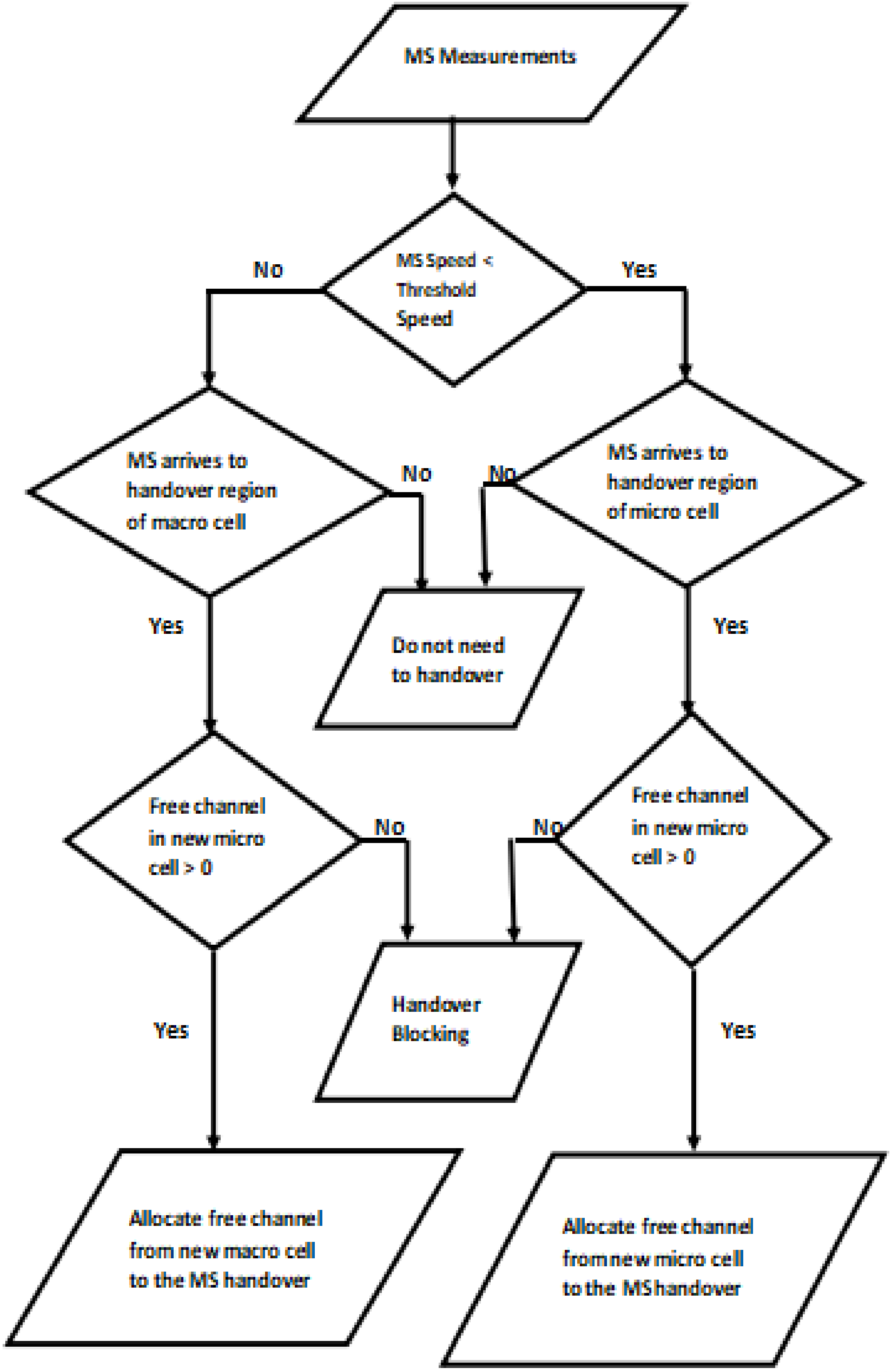

Figure 9: Flow Chart of handover in Umbrella Cell.

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4. Simulation Result

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 Figure. (10). The second system shown in Figure. (11) uses the umbrella cell. Macro cell radius is 6000 m while micro cell radius is 2000 m.

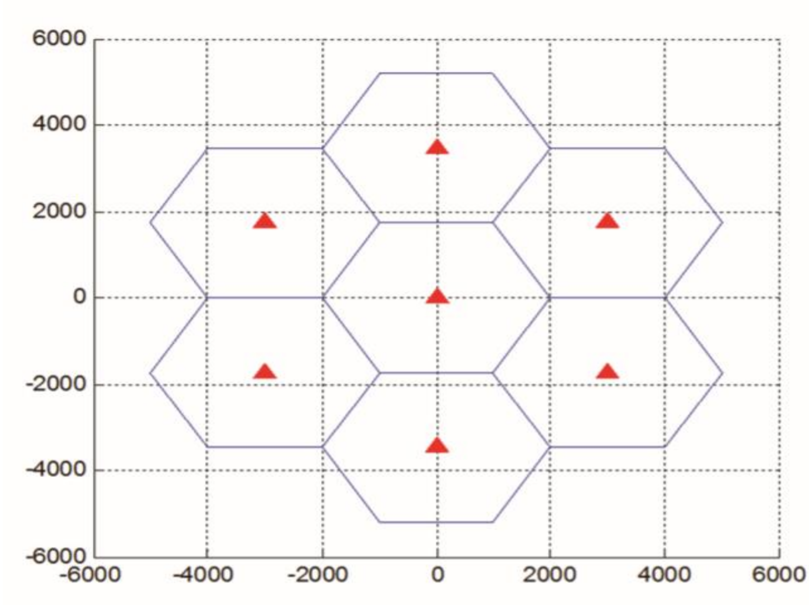

Figure 10: First model cells

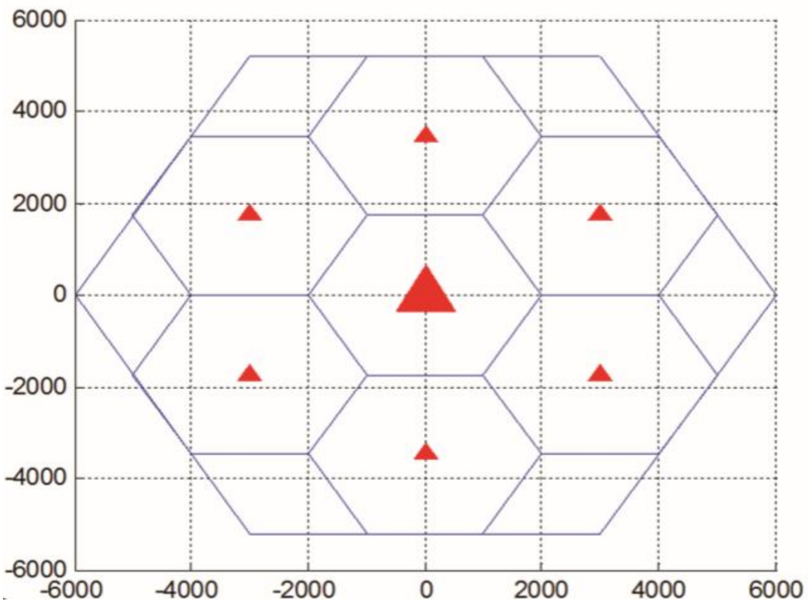

Fig 11: Second model cells

Users uniformly distributed across both models are generated by each user's direction and speed and the direction is periodically updated. The first cell has 20 channels assigned, while the second model provides four channels for the umbrella cell (macro), the remaining 16 channels are assigned to every micro-cell. The second model is designed for each cell. Therefore, the number of channels in the cell of the umbrella is as follows:

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

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 :

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

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.

The position of each mobile station is monitored periodically during the simulation (duration 6 hours) each second provided that the position measurement by the GPS device is carried out. By reading more than one document and then splitting distance over time, user speed can be evaluated. The speed of the consumer is then known, which is if it is one or more speeds equal to the critical one.

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. 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.

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

Tab 1: Simulation Factors

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

Tab. 2: Umbrella Cell Factors

4.1 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).

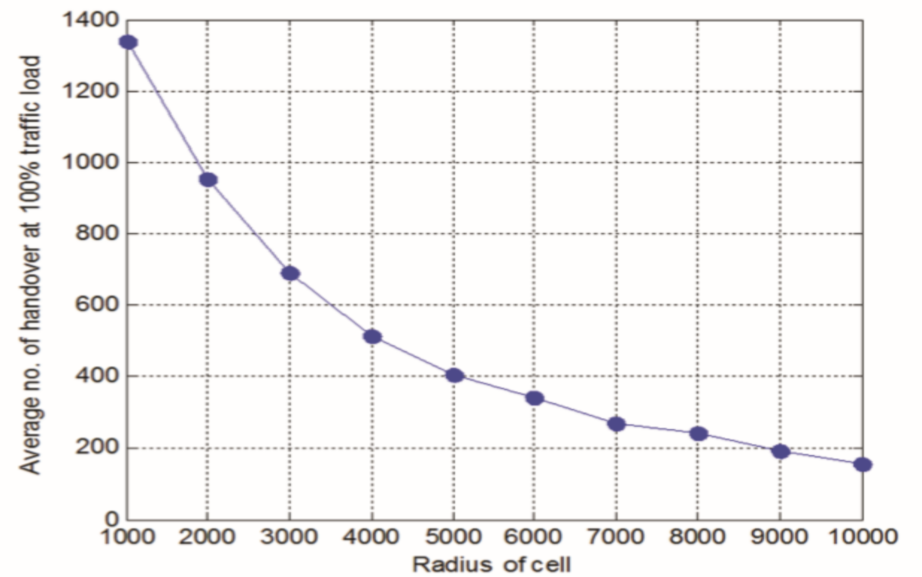

Fig. 12: Average number of handovers with radius of cell at 100% traffic load.

Figure (12) indicates the relation with the cell radius of the number of handovers when the load is 100%. Increasing the cell radius reduces the number of transfers, since high speed users may leave over one small cell during a single call, so more than one transfers is required. Although large cells need fewer transfers during one call or without having to transmit. In contrast with the rest of the structures, this practical umbrella cell is used with relatively broad radius.

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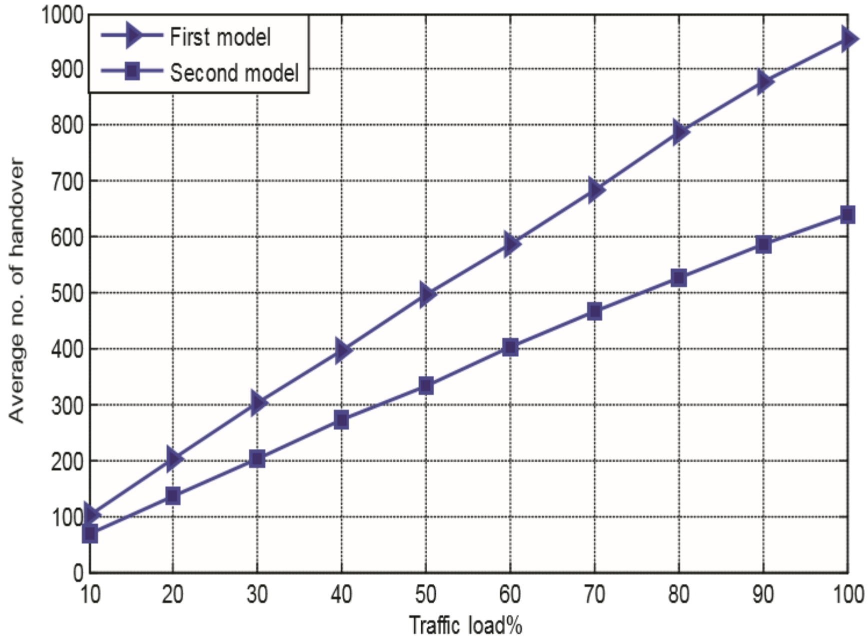

Fig. 13: Average number of handover with traffic load.

Figure (13) demonstrate the relationship between the average number of first and second models handover and traffic load. This figure shows that, however in the second model, the number of transfers increased proportionally directly to the load change. In the first model, the number of transfers from 102 transfers in traffic loads of 10% to 955, where the traffic load is 100%, due to an growing number of users in the traffic overload. The second model indicates a substantial reduction in the number of transfers in contrast to the first model. With 10 percent traffic, 69 transfer numbers, and almost 641 transfers with 100 percent traffic load, 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.

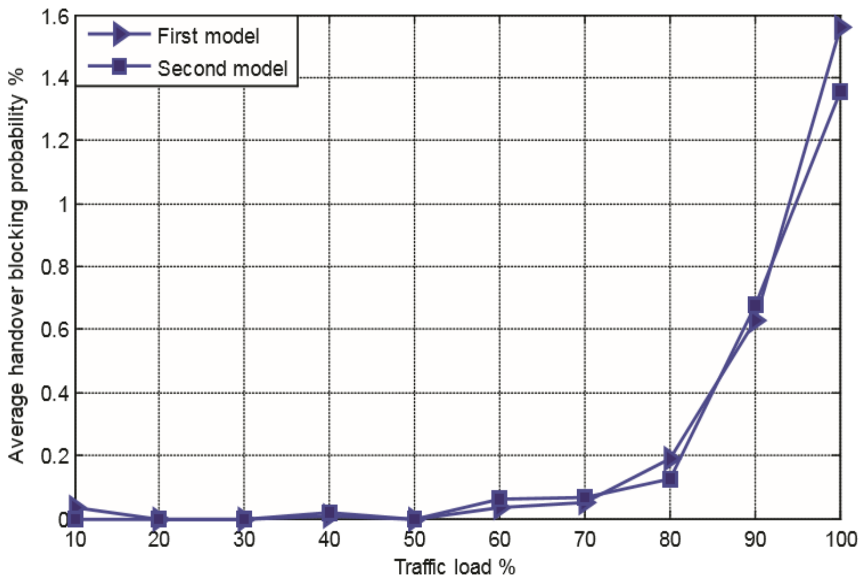

Fig. 14: Average percentage blocking probability with traffic load.

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Figure. (14) 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%.

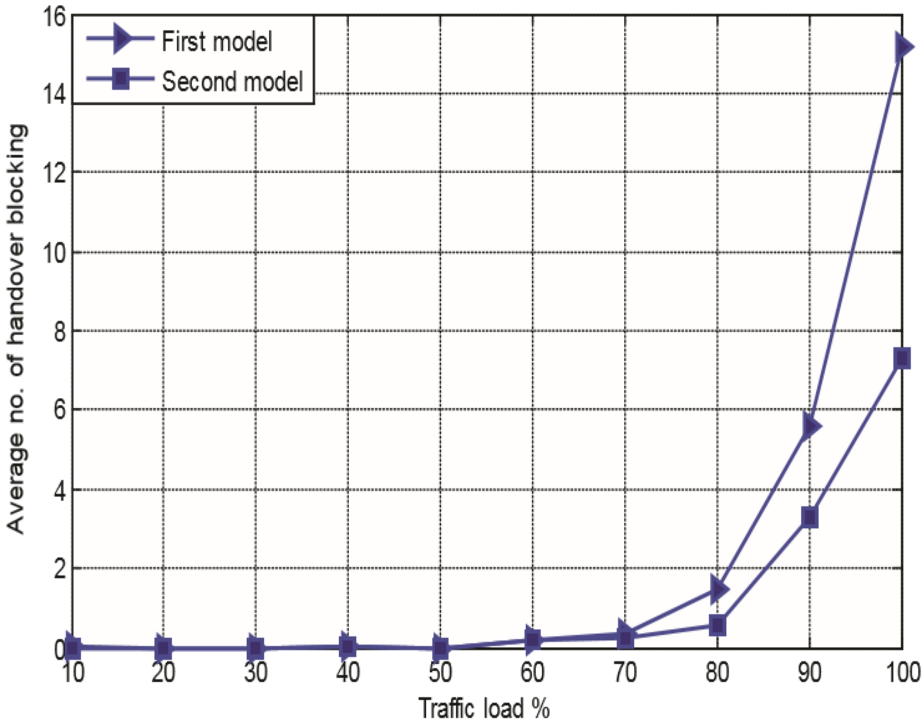

Fig. 15: Average number of blocked handover with traffic load.

Figure compared. (15) demonstrates the progress of the transfer mechanism in the second model, which is the relationship between the average number of blocked deliveries and traffic load. For the two models with low loads the number of blocked transfers is small but the number of blocked deliveries is increased for high loading of traffic. For example , 90% of traffic is blocked by six transfers for the first model and 3 for the second. for the second model. With a load of 100%, the first model includes over 15 blocked handovers and the second model is blocked with less than 8 handovers . 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.

5. Conclusion

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

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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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