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A New Method of Intelligent Handover management in 5G Communication Networks-IHMCN

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***Abstract*—One of the most promising approach in macrocell and femtocell networks is to improve the network capacity and network coverage. This regard handover modified technique is needed for existing networks to support the integrated microcell and femtocell network. The signal-to-interference ratio measurement parameters and quality of service (QoS) should be considered for handover between microcell and femtocell. In the conventional networks the regular and needless handover therefore need to be optimized to enhance the overall performance of integrated macrocell-femtocell network. However, not a sufficient amount of work has been carried out so far in this direction. To bridge this research gap, we propose an efficient and intelligent management handover algorithm for handovers in between microcell and femtocell to minimization of unnecessary handover and maintain the quality of service (QoS) while taking the signal-to-interference ration, received signal strength (RSS), user type and availability of bandwidth under consideration. We simulate the proposed handover optimization scheme to validate the performance. The numerical results show that the proposed algorithm revenues a higher probability that the user will be properly allocated to the femtocell while upholding number of handovers at the same level.**

***Keywords*—efficient handover algorithm, macro/femtocell network, signal-to-interference, quality of service, 5G network**

I. INTRODUCTION

In the recent development of wireless technology, the femtocell network is a faithful way of providing better quality of service to indoor as well as outdoor users. The femtocells are small and low power cellular network access points classically designed for indoors and small business units [1, 2]. These are connected with the service network provider through broadband. It usually supports up to 16 active mobile users as this concept is applicable to all the standards such as Global System for Mobile (GSM), Code Division Multiple Access (CDMA)-2000, Time Division Synchronous Code Division Multiple Access (TD-SCDMA), WiMAX (worldwide interoperability for microwave access) and LTE (long term evolution) solutions [1–3]. In this network, some very low femtocells are implemented in macro base station coverage that usually uses high transmit power to cover large geographic area [4–6]. To support the successful inbound mobility is a challenge that corresponds the handover from macrocell to macrocell, microcell to femtocell, femtocell to macrocell and femtocell to femtocell [1]. To achieve this, we purpose an efficient management handover algorithm designed to be used for handovers for all the above-mentioned scenarios in the network. This efficient management handover mechanism is related to the time user equipment stays in the area of femtocell and it also differentiate the pre-registered user and the un-registered user equipment's in the network. The co-existing of dense number of femtocells within the coverage of macrocell network is shown in Fig. 1.

Thousands of femtocells are implemented within the coverage of macrocell area which creates an interference problem in the network. Minimization of interference is identical problematic and bringing it to the absolute zero value is nearly impossible.

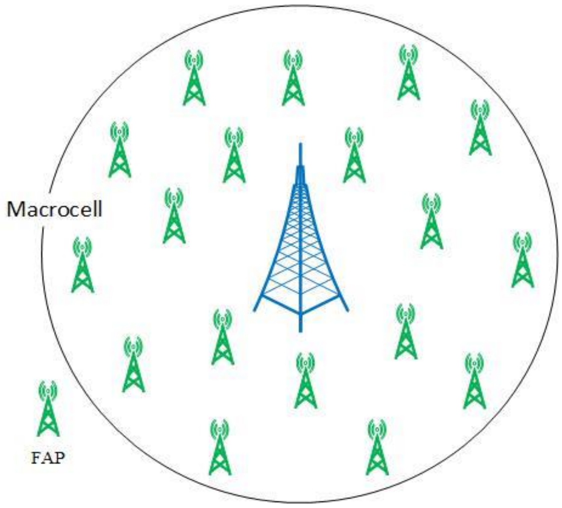

Figure 1. Dense femtocells co-existing with microcells.

In order to overcome this problem, the interference graph is created and the coloring algorithm is applied to

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get the chromatic number, which generates the number of zones in the network. Once getting the number of zones the users of different zones are randomly assigned or by using signal to interference ratio (SINR) value on that basis that the number of channels is allocated to each zone [7]. Once users are assigned to the zones the implementation needs some basic requirements for handover schemes such as:

- To maintain the service quality not only before and after the handover but also needs during the handover process.
- The handover service to be continued as normally as they were done before the handover.
- The handover should remain seamless between all the generations of technology

A. Related Work

Many handover techniques [8] have been created recently for a variety of environmental, agricultural [9], and medical circumstances, but the majority of these techniques are ineffective for handover between domains. The inter-domain handover techniques were unable to concurrently meet the demands of mutual authentication, perfect forward secrecy, traceability, and key agreement [10]. In communication networks, soft computing techniques like fuzzy controllers, neural networks [11], chaos theory [12], and genetic programming are frequently employed. In 5G networks, soft computing techniques were employed to support decision-making and provide greater capabilities for handling traffic [13] through congestion management [14]. Additionally, the device-to-device (D2D) communication technique [15] is becoming more popular in academics and industry due to its benefits, including increased throughput, robustness, energy efficiency, and offloading of cellular traffic [16]. Health-care organizations may now offer remote monitoring to more patients thanks to 5G technology [17], which offers a higher capacity and reduced latency. The handover strategy, which increases security and reduces latency [18, 19], also employs elliptic curve cryptography. In 5G networks, HO control parameters are typically adjusted using velocity-based self-optimization techniques like Deep Hyper Optimization (DHO).

Different handover techniques based on artificial intelligence (AI) have been utilized in the past like artificial neural networks (RNA), fuzzy logic, ontologies, and deep learning [20]. The authors created an exhaustive survey on mobility management by critiquing the state-of-the-art solutions' preparation for the 5G and B5G cellular networks, which are the next two generations of cellular networks. Prior to the development of their own qualitative performance indicators for the current mobility management systems, the mobility management requirements of the following generations of cellular networks were first recognized. Additionally, they included in their work a description of the standards for both legacy networks and 5G, as well as the research being done to satisfy these criteria.

In 5G networks, HO control parameters are typically adjusted using velocity-based self-optimization techniques [21] like DHO. It was developed a lightweight physical layer authentication approach that avoids computer complexity and reduces authentication delay [18, 22]. For safe and efficient functioning, the handover technique is utilized to carry out accurate and trustworthy exchange of task-relevant information [23]. The handover technique's goal is to provide accurate and dependable conveyance of information important to the work across transitions. The sophisticated way of handover methodology, modular handover ensures continuity of safe and effective working.

B. Contribution

In this paper, we concentrated on one of the most important issue of handover between macrocell and femtocell to overcome the handover failure and reduce the handovers. The efficient management handover algorithm is developed for handovers between microcell and femtocell for minimization of unnecessary handover and maintain the quality of service (QoS) while taking the signal-to-interference ration and availability of bandwidth under consideration. Therefore, utilization of femtocell network and throughput are also improved.

II. SYSTEM MODEL

In femtocell/macrocell there are many options possible to integration of network. Each option approaches with an adjustment term of scale but the best option depends on existing network operator capabilities the network expansion plan in future [24]. Fig. 2 shows the femtocell network development basic connectivity. The seamless switch ability between the femtocell and macrocell networks is a main driver for development of femtocell network. In femtocell, the handover from macrocell to femtocell is the most thought-provoking issue [24, 25]. The handover from macrocell to femtocell is also a complex issue compared to femtocell to microcell handover [26]. In the mechanism of handover, the mobile station needs to select appropriate target femtocell among many candidates. The handover decision interference level should also be considered. Thus, the handover from macrocell to femtocell consists more functionality than existing macrocell to macrocell networks [5–7, 27].

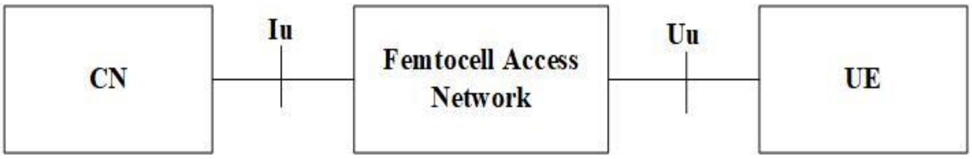


Figure 2. System architecture of femtocell.

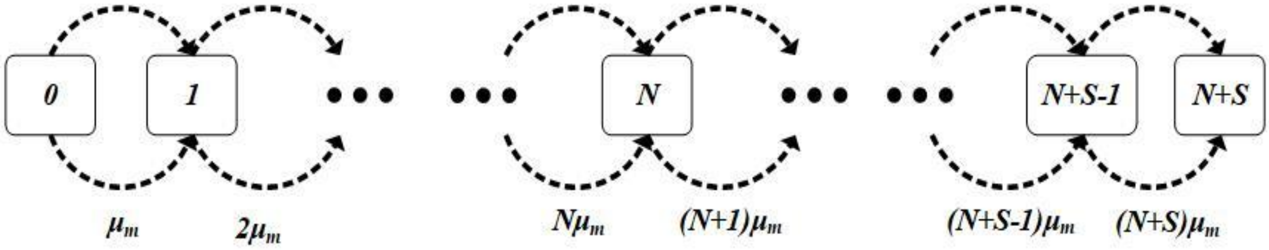


Figure 3. Markov chain of macrocell layer.

Fig. 3 shows the overlaid macrocell layer of Markov chain for the analysis of queuing, where in system the number of cells is presented by the state of the system. The macrocell system provides additional S number of states by adaptive QoS policy to support handover calls. These handover calls include all the calls in between macrocell to macrocell and macrocell to femtocell handover calls [28]. The arrival rates of total originating call are seeing all n number of femtocells inside the area covered by macrocell and coverage area of only macrocell are represented by the symbols $\lambda_{o,f}$ and $\lambda_{o,m}$ respectively [29, 30]. The total macrocell-to-macrocell, macrocell-to-femtocell, femtocell-to-macrocell and femtocell-to-femtocell arrival rates of handover call in the area covered by the macrocell are represented by the symbols $\lambda_{h,mm,}$ $\lambda_{h,mf,}$ $\lambda_{h,fm,}$ and $\lambda_{h,ff}$.

The microcell (femtocell) system blocking probability of new call originating is mentioned as $P_{B,m}$ $(P_{B,f})$. In macrocell (femtocell) system dropping probability of handover calls are $P_{D,m}(P_{D,f})$. K is the maximum calls which femtocell can accommodate [27, 28]. We define the release rate of channel in macrocell (femtocell) as μ_m (μ_f). The macrocell layer and femtocell layer average channel release rates are calculated as follows,

$$\mu_m = \mu_m(\sqrt{n+1)} + \mu \tag{1}$$

$$\mu_f = \mu_f + \mu \tag{2}$$

where the duration of average cell, dwell time average cell for femtocell and the dwell time average cell for the macrocell are represented as $1/\mu$, $1/\eta_f$ and $1/\eta_m$.

The average call blocking and average probability of dropping call can be calculated as,

$$P_{B,f} = P_{D,f} = P_f(K) = \frac{\left(\frac{\lambda_{T,f}}{n}\right)^K \frac{1}{K!\mu_f^K}}{\sum_{i-o}^{K}\left(\frac{\lambda_{T,f}}{n}\right)^i \frac{1}{i!\mu_f^i}} \tag{3}$$

where $\lambda_{T,f} = \lambda_{f,o} + \lambda_{h,mf} + \lambda_{h,ff}$

The average call blocking and the probability of average call dropping can be calculated as,

$$P_{B,m} = \sum_{i=N}^{N+S} P(i) = \sum_{i=N}^{N+S} \frac{(\lambda_{m,0}+\lambda_{h,m})^N {\lambda_{h,m}}^{i-N}}{i!\mu_m^i} P(0) \tag{4}$$

$$P_{D,m} = P(N+S) = \frac{(\lambda_{m,0}+\lambda_{h,m})^N {\lambda_{h,m}}^{i-N}}{(N+S)!\mu_m^i} P(0) \tag{5}$$

where $\lambda_{h,m} = \lambda_{h,mm} + \lambda_{h,fm} + P_{D,fd}\lambda_{h,ff}$ and

$$P(0) = \left[\sum_{i=0}^{N} \frac{(\lambda_{m,0}+\lambda_{h,m})^i}{i!\mu_m^i} + \sum_{i=N+1}^{N+S} \frac{(\lambda_{m,0}+\lambda_{h,m})^i(\lambda_{m,h})^{i-N}}{i!\mu_m^i}\right]^{-1} \tag{6}$$

The handover call arrival rate of macrocell-to-macrocell and macrocell-to-femtocell is:

$$\lambda_{h,mm} = P_{h,mm} \frac{(1-P_{B,m})(\lambda_{m,o}+\lambda_{f,0}P_{B,f})+(1-P_{D,m})(\lambda_{h,fm}+\lambda_{h,ff}P_{D,f})}{1-P_{h,mm}(1-P_{D,m})} \tag{7}$$

$$\lambda_{h,mf} = P_{h,mf} \frac{(1-P_{B,m})(\lambda_{m,o}+\lambda_{f,0}P_{B,f})+(1-P_{D,m})(\lambda_{h,fm}+\lambda_{h,ff}P_{D,f})}{1-P_{h,mm}(1-P_{D,m})} \tag{8}$$

The handover call arrival rate of macrocell-to-macrocell and macrocell-to-femtocell is:

$$\lambda_{h,ff} = P_{h,ff} \frac{\lambda_{f,o}(1-P_{B,f})+\lambda_{h,mf}(1-P_{D,f})}{1-P_{h,ff}(1-P_{D,f})} \tag{9}$$

$$\lambda_{h,fm} = P_{h,fm} \frac{\lambda_{f,o}(1-P_{B,f})+\lambda_{h,mf}(1-P_{D,f})}{1-P_{h,ff}(1-P_{D,f})} \tag{10}$$

where, $P_{h,mm}$ is the probability handover of macrocell-to-macrocell, $P_{h,mf}$ is the macrocell-to-femtocell handover probability, $P_{h,fm}$ is the femtocell-to-macrocell handover probability, $P_{h,ff}$ is the femtocell-to-femtocell handover probability. However, probability handover of all the above mention scenarios is calculated as follows. The probability handover of macrocell-to-macrocell is

$$P_{h,mm} = \frac{\eta_m}{\eta_m+\mu} \tag{11}$$

The macrocell-to-femtocell handover probability is

$$P_{h,mf} = n\left(\frac{r_f}{r_m}\right)^2 \frac{\eta_m\sqrt{n}}{\eta_m\sqrt{n}+\mu} \tag{12}$$

The probability of handover of femtocell-to-macrocell is

$$P_{h,fm} = \left[1 - n\left(\frac{r_f}{r_m}\right)^2\right] \frac{\eta_f}{\eta_f+\mu} \tag{13}$$

The probability of handover femtocell-to-femtocell is

$$P_{h,ff} = (1-n)\left(\frac{r_f}{r_m}\right)^2 \frac{\eta_f}{\eta_f+\mu} \tag{14}$$

The radius of macrocell and femtocell are represented as r_m and r_f.

III. PROPOSED HANDOVER ALGORITHM

Fig.4 shows the femtocell access mode within the macrocell coverage area. In the femtocell access mode, there are two types of users, pre-registered and un-registered users. Pre-registered users are giving service on the basis of priority while if there is surplus bandwidth than only un-registered users are able to use the services in femtocell.

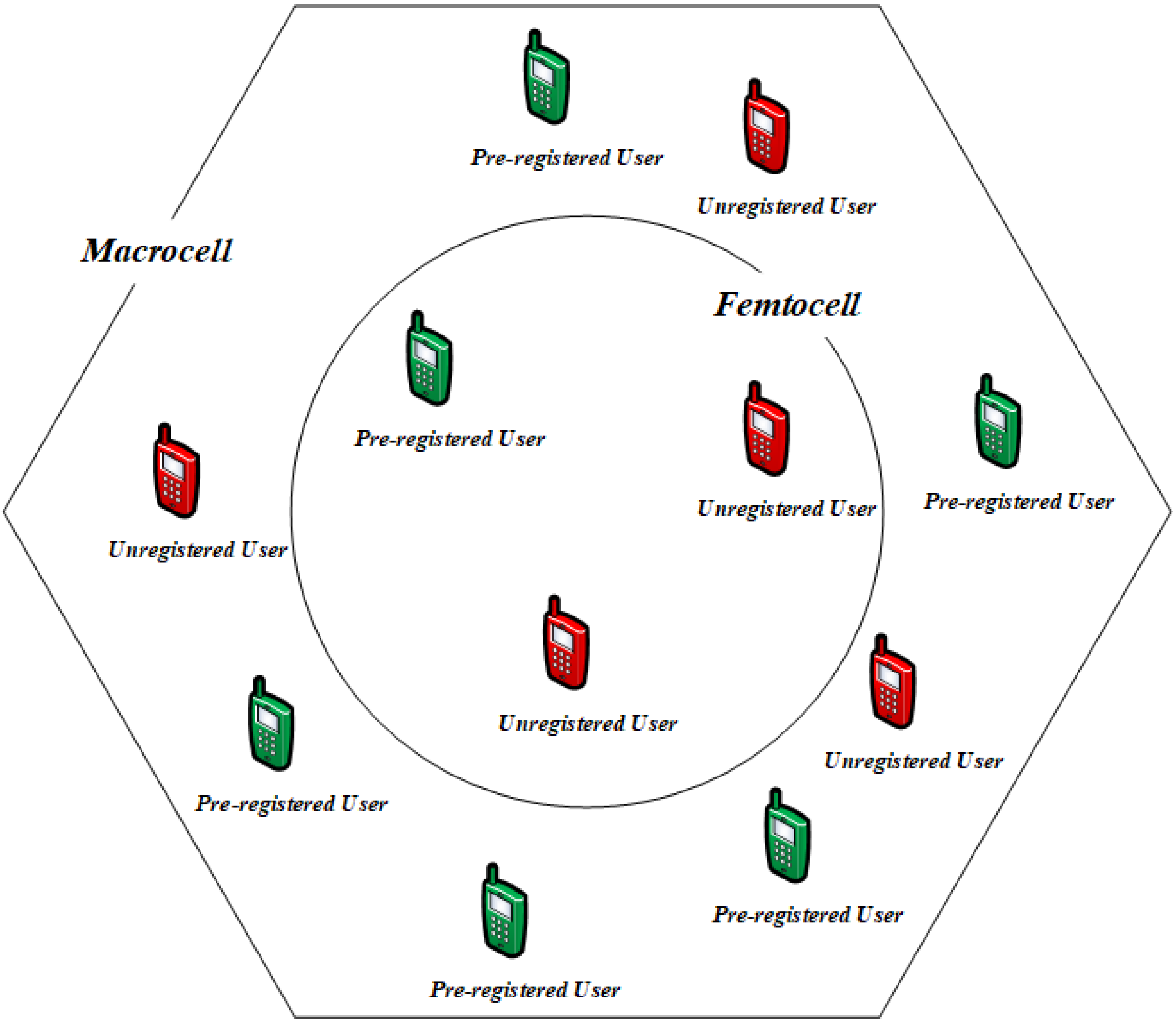


Figure 4. Access mode of femtocells within the coverage area of microcell.

The coverage area of femtocell is very small, if the users are moving in high speed, the duration of stay time in femtocell is very less which causes unnecessary handovers.

These all uneven/unnecessary handovers decrease the quality of service (QoS) and the all over capacity of system. To improve the service level, the proposed handover management algorithm is developed to diminish the number of unnecessary handovers whenever the user of macrocell moves into the coverage area of femtocell and vice versa in Fig. 5. The proposed handover algorithm flowchart which considers the received signal level, the signal to interference level, user type (pre-registered or un-registered), duration of users maintains the level of signal above the level of threshold and the capacity that a femtocell can accept. When the RSS level is advanced than the threshold level, the femtocell gateway whether the user is pre-registered or un-registered, if user is pre-registered than next procedure of handover is performed [new]. If the user is un-registered, the user will stay in femtocell till the threshold time interval (T) before continuing to next procedure of handover. Thus, the number of unnecessary handovers can be reduced by the threshold time interval. The threshold is the least required level for the handover decision from macrocell to femtocell.

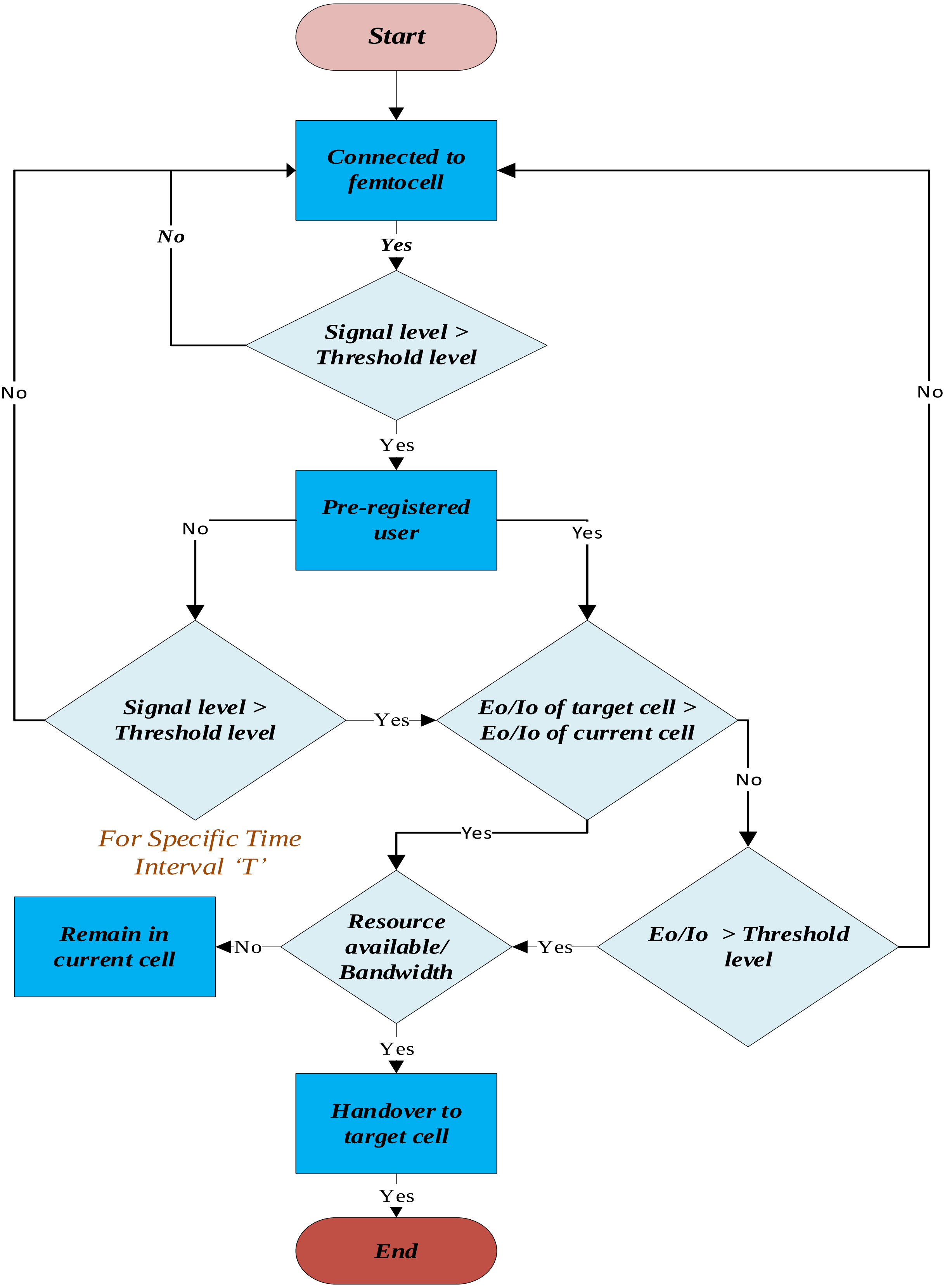


Figure 5. Flow chart of proposed handover algorithm.

IV. Simulation and Results

The work proposed in this paper has been simulated with MATLAB software. In Fig. 6 the simulation framework is approached. We considered the network scenario where the number of femtocells is organized over the area covered by macrocell. The measurement description of MS, femtocell access mode, list of registered users, traffic load along with mobility and call request and other related information for handover decision are made. The simulation parameters used in this approach are stated below in Table I.

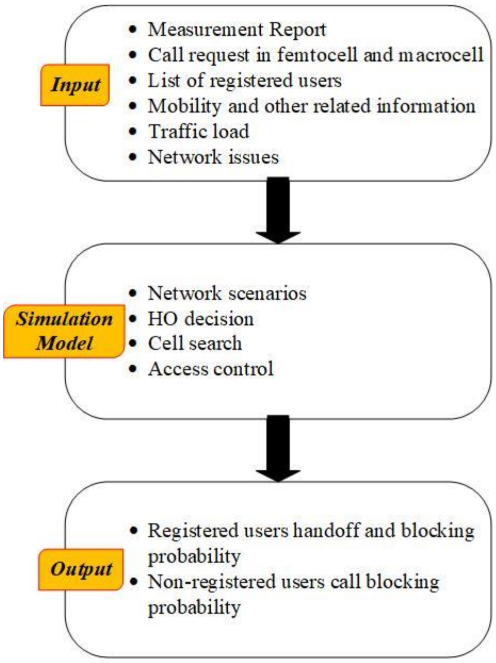


Figure 6. Framework for simulation.

Fig. 7 shows the different handover probabilities effect as number of organized femtocells are increasing within the coverage of macrocell area. The handover probability of femtocell to macrocell is high as compared to femtocell to femtocell and macrocell to femtocell. While increasing the deployed femtocell the handover probability is significantly increasing.

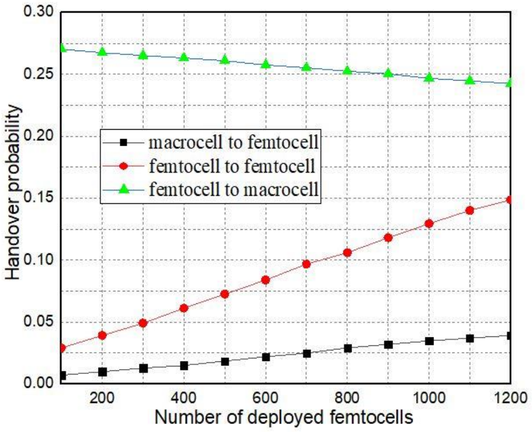


Figure 7. The probability of handover with the enlarged figure of femtocells.

Fig. 8 shows that minimization of number of unnecessary handover due to the proposed algorithm. The user moves from the macrocell to the femtocell and again from the femtocell to the macrocell for different schemes. A threshold time of 20 seconds and 10 seconds reduces the unnecessary handover.

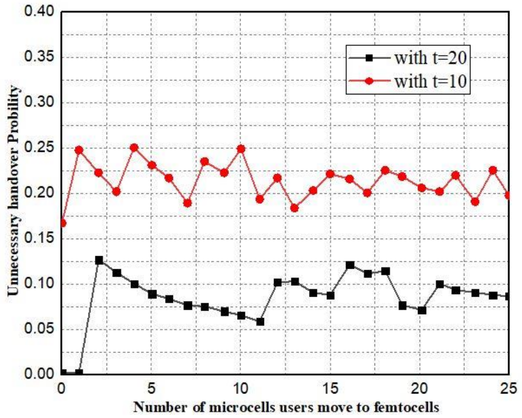


Figure 8. Probability minimization of unnecessary handover for user moving to femtocell from marcocell area.

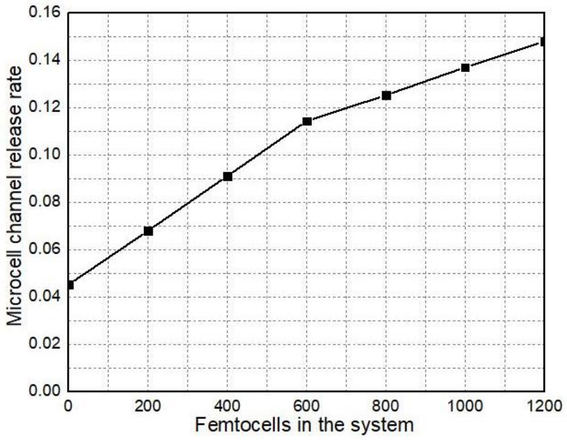


Figure 9. Channel release rate in serving macrocell network.

Pseudo code of proposed handover algorithm

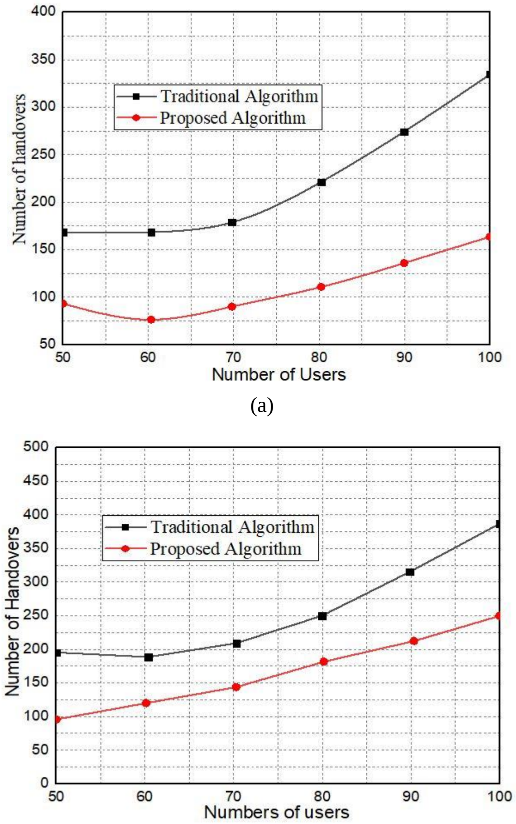
```
Current station and target station
User is connected initially macrocell
From all the femtocells find the femtocell, such that
$RSS_{target} \geq RSS_{thf}$
Add femtocell to list
From list find target femtocell
{{
If $RSS_{target} \geq RSS_{current}$, then find
Eo/Io of femtocell -> Eo/Io of macrocell
{
If yes, then
    Find available BW
Else find
{
If Eo/Io> threshold level, then
    Find available BW
Endif
Endif
}}
Handover to target femtocell
Else
Remain in microcell
Endif
}
```

The channel release rate in a serving macrocell network refers to the rate at which radio channels are released or freed up for use by other mobile devices in the network and this is shown in Fig. 9. The Fig. 10(a, b), shows at different velocities of 30 kmph and 120kmph the variation of handover numbers with the increase in figure of users. In this scheme the handover margin increases and subsequently reduces the number of handovers. Therefore, increasing the handover margin will reduces the unnecessary handovers. When the users are near to the base station the margin of handover can be increased to the maximum and if the users are near to the boundary the margin can be decreases to the minimum. Which helps us to reduce the unnecessary handovers as well as packet loss.

TABLE I. THE SIMULATION PARAMETERS [28]

Parameters	values
Shape of femtocell coverage area	circular
Radius of femtocell	10m
Average velocity of user in femtocell coverage	0.25m/sec
Call life time and user velocity	Exponential distribution
Femtocells in macrocell coverage area	50
Threshold value of received signal (RSS)	-90(dBm)
Max. transmit power (FAP)	10 (mw)
bandwidth	10 MHz

Fig. 9 shows the release rate of channel in macrocell to increase the load transfer rate from the macrocell to the femtocell networks.



(a)

(b)

Fig. 10 (a). Number of handover vs number of users at 30kmph; (b). Number of handover vs number of users at 120kmph.

Fig. 11 shows the important parameter of handover latency while increasing the user speed, the latency of handover is the delay between the moment when handover should be placed and the actual handover, which happens due to protocol verification and reception signal. It clarifies that increasing speed increases the initially latency of handover and then becomes saturated.

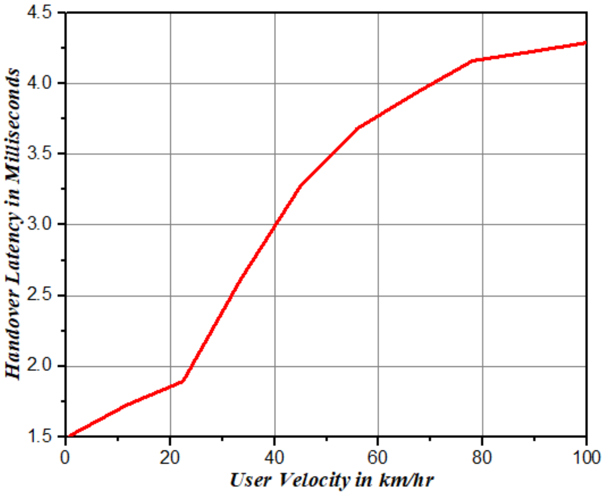


Figure 11. Handover latency vs user velocity.

V. CONCLUSION

The femtocell in present technology is studied due to its advantages and potential benefits and possibility to discharge the macrocell. The femtocell is having the bright future in nowadays technologies which provide high network access at low price for indoor users. In this paper, we have developed an efficient management handover algorithm to overcome from unnecessary and reduce the handovers in between macrocell and femtocells and maintain the quality of service (QoS) while taking the signal-to-interference ration, received signal strength (RSS), user type and availability of bandwidth under consideration. While comparing with other traditional algorithms, the proposed algorithm handover minimize scheme reduces the number of handovers and also overcome from macrocell to femtocell unnecessary handovers and vice versa in the networks. This proposed scheme might be much helpful for future research directions in macrocell and femtocell handovers.

CONFLICT OF INTEREST

The authors declare no conflict of interest".

AUTHOR CONTRIBUTIONS

Altaf A. Balkhi and Ishfaq B. Sofi did all the simulation and experimental work. Javaid A. Sheikh formulated the conceptual idea. Zahid A. Bhat did all the typecasting while as G.M. Mir did the proof reading. In addition to this, all authors had approved the final version.

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