IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Novel Approach Model For Indoor Call Admission Control For 5G In Integrated Macrocell/Femtocell Networks

SUMIT PATHAK[1*], Prof. V.K. SARASWAT[2]

Research Scholar,[1] Department of Computer Science, D.R. Bhimrao Ambedkar University, Agra, India,

ORCID iD: https://orcid.org/0000-0002-0469-6637

Research Supervisor,[2] Department of Computer Science, D.R. Bhimrao Ambedkar University,

Agra, India, ORCID iD: https://orcid.org/0000-0003-0354-5498

Abstract: In view of the inadequacy of wireless resources, such as radio channels, and user mobility, achieving quality of service (QoS) in wireless networks is a huge challenge. Call admission control (CAC) is a proven approach for network QoS provisioning.With The ultimate objective of the femtocellular network deployment is the integration of dense femtocells with macrocells. Integrated macrocell/femtocell networks are unquestionably capable of providing high data rates for indoor users and offloading massive traffic from macrocellular networks to femtocell networks. Spectrum, power regulation, higher functioning capacity, and high-quality networks are all necessary due to the substantial rise in internet users and the prerequisites for larger data capacity per user.

Keywords: Call Admission Control, femtocell, 5G, IOT, Macrocell

1. Introduction:

With the inception, 1G was analog manner of communication, the subsequent evolution was 2G technology, or the Global System for Mobile (GSM). The advancement of the Universal Mobile Telecommunications System (UMTS) was made possible by the implementation of 3G technology, which is a huge upgrade over 2G in terms of data rate. The increasing data rates and expectation for bandwidth necessitated the creation of 4G technologies like Mobile Wi-max and LTE. 5G is the pioneer[1] of modern communication systems. Femtocellular networks are one of the most promising technologies to address the huge demand for wireless capacity by diverse wireless applications for future wireless communications. Femtocells use cellular spectrum. Femtocell design utilizes no new equipment. Femtocells have high data rates and cheap deployment costs. Thus, this technology aims to mass-deploy femtocells. A well-designed femtocell/macrocell-integrated network can shift massive [2]traffic from crowded and expensive macrocellular networks to femtocell networks. The femtocell/macrocell-integrated network architecture's biggest benefit for wireless operators is offloading a lot of traffic to femtocell networks. This will save capital investment, operating and implementation costs and improve cellular network reliability

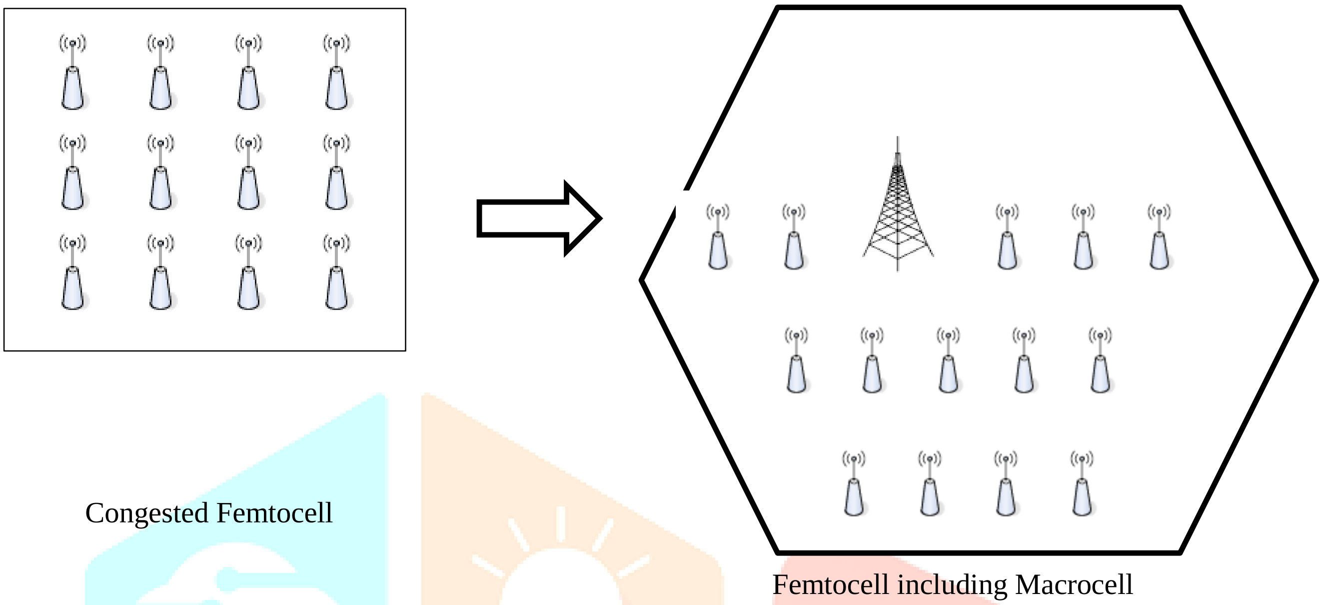


Figure 1: Femto cellular network descriptive view

Figure 1 illustrates a scenario in which femtocellular and macrocellular networks coexist. Under the macrocellular network's umbrella, thousands of femto access points (FAPs) or Micro acess points (MAPs) have been set up. Overlapping macrocell coverage areas see handoffs between macrocells and femtocells. When several femtocells are squeezed into a specified area, handoffs occur more frequently. Users are able to move around with minimal disruption thanks to smooth handoffs between femtocells and macrocells. The handoff of calls from macrocells to femtocells isn't strictly necessary for seamless transit, but it can significantly lighten the workload on macrocell networks.The transition to 4G based on LTE (Long Term Evolution) technology has led to a significant increase in throughput (sometimes more than 100 Mbps) because the architecture has been improved significantly and voice over IP has been markedly enhanced (VoIP).

Acquiring the dense scale femtocells to work with the macrocellular network is challenging for an assortment of reasons. The management of the handover is one of several complex challenges. With the need for a good call admission control (CAC) policy, the handover calls can be facilitated well. So, we recommend a CAC policy to consider multiple kinds of calls. Due to the constraints in femtocellular networks, the proposed CAC doesn't have an impact between calls that start in a new cell and calls that switch to a new cell[3]. By offering QoS adaptation, the CAC delivers calls that are being transferred in the overlaid macrocellular network a higher priority.So, the macrocellular network can easily manage a very large number of handover calls from femtocells and adjoining macrocells.

The remaining sections of this work are structured as follows. The CAC's guidelines are outlined in Section II. Section III provides the detailed traffic model and queuing analysis for combined macrocell/femtocell networks. In Section IV, we describe and compare the outcomes of our performance evaluations of the various proposed solutions. As we near the end of this book, we provide Section V.

2. Proposed Model-

Any and all wireless networks would benefit greatly from a fine-tuned CAC(Call Admission Control). The macrocell's limited yet useful resources. To that end, integrated macrocell/femtocell networks require stringent controls over the admission of mixed-traffic calls within the macrocell's region of coverage. It is the goal of the strategy we propose to redirect as many macrocell calls as possible to femtocellular networks. There are three components to the proposed CAC. The first for macrocellular BS calls, the second for MAP calls, and the third for raw originating calls (microcellular acess points). We present the bandwidth degradation technique of the QoS adaptive[5] multimedia traffic in order to support a greater invasion of femtocell-to-macrocell and macrocell-to-macrocell handover calls. Existing QoS adaptable multimedia traffic must be decreased so that the macro cellular network can support handover calls.

This release amount is based on the total number of active sessions within the macro cellular network and the highest amount of QoS degradation that each call may sustain. The recommended bandwidth of a macrocell is Let, r each call's minimal bandwidth min. This means that the minimum amount of time before a Quality of Service (QoS) can release bandwidth for a handover call is G, where G is the total bandwidth capacity of the system, and G0 is the percentage of that bandwidth that is currently being used by active calls. Using the suggested method, the CAC checks the incoming call type at the time the call is launched, with 5G networks using the Ga of G-G o. Calls that are part of a macrocellular network's resource handover have greater priority than new calls. When a call comes in, the CAC makes sure the area is covered by femtocells. If femtocell service is available, MAP will connect the call before any other method. If the necessary resources are free, MAPs will take on new call initiations. When the foregoing condition is not met, the call is routed over the overlay macrocellular network. The macrocell infrastructure does not allow a Quality of Service (QoS) degradation method for incoming calls.

Microcell/femtocell and femtocell-to-macrocell handovers are distinguished by the CAC at [6-7]. When the signal strength from the serving FAP (S-FAP) decreases, the MS initiates femtocell-to-femtocell or femtocell-to-macrocell handover to improve 5G latency and high data throughput. If the T-FAP does not have enough resources to complete the handover or if no alternative FAP is available, the call is routed to the macrocellular network. If the macrocell system does not have enough available resources to handle the call, the CAC policy will downgrade the quality of service for existing calls in order to free up bandwidth. The CAC policy for handover calls allows the bandwidth to be reduced from r to min. After that point, the call will be terminated if there is not enough bandwidth to continue.

3. Proposed Traffic Model-

CAC for 5G and higher bands will be known for providing better data rates which approximation analysis can be modelled by Markov chain which is a stochastic model for depicting a succession of possible occurrences where the probability about each event depends solely on the state obtained in the preceding event. Fig 3illustrates a Markov Chain for the interlaced macrocell layer queuing analysis, where the system states signify the quantity of calls in the network.

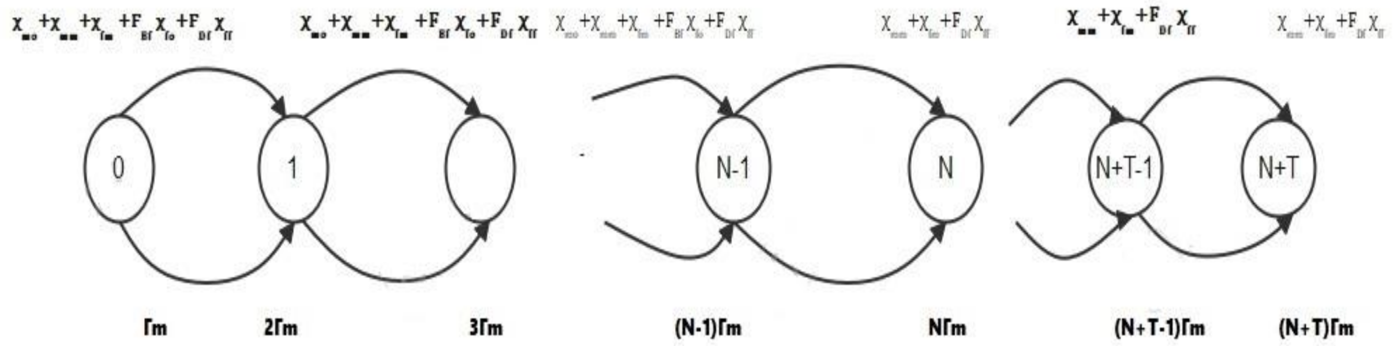


Figure 3: Markov Chain Reaction for CAC

the symbols χ_{fo} respectively, is the sum of all call arrival rates for femtocells inside a macrocell coverage region, where n is the number of femtocells or microcell. and χ_{mo} representcoverage area of macrocell.

χ_{mm}= rate of macrocell-macrocell handover call arrival,

χ_{ff}= rate of femtocell -femtocell handover call arrival,

χ_{fm} = rate of femtocell-macrocell handover call arrival,

χ_{mf} = rate of macrocell-femtocell handover call arrival

F_{Bm} $\{F_{Bf}\}$ =probable outcome for new originating call blocking in macrocell{femtocell}zone.

F_{Dm} $\{F_{Df}\}$ = In the macrocell-femtocell zone, handover call dropping is likely to occur.

The maximum simultaneous call volume for a femtocell system is R. Call delay in a femtocell is low, and data rates are high, hence a handover priority mechanism isn't necessary in femtocellular networks. All calls in a femtocellular network originate from macrocells and are relayed to the smaller cells.

Let $\Gamma_m\{\Gamma_f\}$ b the rate of macrocell channel release (femtocell).

The typical channel release rates for the femtocell and macrocell layers are as follows:

$$\Gamma_m = \psi_m \left(\sqrt{n} + 1\right) + \Gamma \quad (1)$$

$$\Gamma_f = \psi_f + \Gamma \quad (2)$$

Where,

(1/Γ) Taking all calls into account, the average call duration, $(1/\psi_f)$, Time spent on a femtocell conversation on average, $(1/\psi_m)$ Average cell conversation time for macrocell

For femtocell utilized in 5G and upper band of frequency $F_{D,f} = F_{B,f}$ can be worked out as follows:

$$F_{Df} = F_{Bf} = F_f(R) = \frac{\left(\frac{\chi_{T,f}}{n}\right)^R \frac{1}{R!\Gamma_f^R}}{\sum_{i=0}^{R}\left(\frac{\chi_{T,f}}{n}\right)^i \frac{1}{i!\Gamma_f^i}} \tag{3}$$

$Where\ \chi_{T,f} = \chi_f + \chi_{mf} + \chi_{ff}$

Our suggested technique facilitates QoS adaptation/degradation for macrocell layer handover calls.Thus we can calculate the probability for macrocell networks for call blocking and hand over call dropping

$$F_{Bm} = \sum_{i=N}^{N+T} F(i) = \sum_{i=N}^{N+T} \frac{(\chi_{mo}+\chi_{hm})^N(\chi_{hm})^{i-N}}{(N+T)!\Gamma_m^{N+T}} F(0) \tag{4}$$

$$F_{Dm} = F(N+T) = \frac{(\chi_{mo}+\chi_{hm})^N \chi_{hm}^T}{(N+T)!\Gamma_m^{N+T}} F(0) \tag{5}$$

$where,$

$\chi_{hm} = \chi_{mm} + \chi_{fm} + F_{Df}\chi_{ff}$

$$F(0) = \left[\sum_{i=0}^{N} \frac{(\chi_{mo}+\chi_{hm})^i}{i!\,\chi_m^i} + \sum_{i=N+1}^{N+T} \frac{(\chi_{mo}+\chi_{hm})^N(\chi_{hm})^{i-N}}{i!\,\chi_m^i}\right]^{-1}$$

Handover Call rate for various topologies can be calculated now,Eq (6) denotes for macro-macro topology(handover arrival rate),Eq(7) denotes Macro-Micro/Femto cell topology (handover arrival rate),Eq(8) denotes Femto-Femto cell Topology(handover arrival rate),Eq(9) denotes Femto-Macro cell Topology(handover arrival rate)

$$\chi_{mm} = F_{mm}\frac{(1-F_{Bm})(\chi_{mo}+\chi_{fo}F_{Bf})+(1-F_{Dm})(\chi_{fm}+\chi_{ff}F_{Df})}{1-F_{mm}(1-F_{Dm})} \tag{6}$$

$$\chi_{mf} = F_{mm}\frac{(1-F_{Bm})(\chi_{mo}+\chi_{fo}F_{Bf})+(1-F_{Dm})(\chi_{fm}+\chi_{ff}F_{Df})}{1-F_{mm}(1-F_{Dm})} \tag{7}$$

$$\chi_{ff} = F_{ff}\frac{(1-F_{Bf})(\chi_{fo})+(1-F_{Df})(\chi_{mf})}{1-F_{ff}(1-F_{Df})} \tag{8}$$

$$\chi_{fm} = F_{fm}\frac{(1-F_{Bf})(\chi_{fo})+(1-F_{Df})(\chi_{mf})}{1-F_{ff}(1-F_{Df})} \tag{9}$$

Where $F_{mm}, F_{mf}, F_{ff}, F_{fm}$ are handover probability for Eq (6,7,8,9)

4. Implementation of Proposed Method:

For both the macrocell and the femto cellnetwork simulations, MATLAB was used as the modelling and simulation tool. Figure 4 illustrates the impact that an increase in the number of femtocells present inside a macrocellular network's coverage will have. The greater the number of femtocells that are utilised, the greater the likelihood of a handoff occurring between femtocells as well as between macrocells and femtocells. In addition, there is a good chance that femtocells and macrocells can communicate with one another. Due to this fact, admission control is an essential component in the process of developing a widespread femtocellular network. As soon as the macrocells and femtocells are brought together, a significant number of the macrocell's calls are transferred to the femtocells through the macrocell-to-femtocell handover calls. This occurs immediately. As a consequence, the macrocell system is able to manage a greater number of incoming calls.

Therefore, the probability of a forced call termination in macrocellular networks is drastically reduced thanks to the integration of femtocell networks.Figure 5 & 6 demonstrates the rise in macro cellular networks' performance as measured by the frequency of forced call terminations. Therefore, the proposed CAC can handle a large influx of calls from both the handover and the new users. Gains in revenue due to better forced call termination performance for the operator as a whole. Figure 7 & 8 emphasis on how the call handover availability for 5G depends on their high bit rates and femto cell is used as a prime game changer for CAC in indoor networks. Figure 9 shows the various network parameters with respect to coverage area for call dropping and its effect on femto cell for wider area coverage and its benefit for indoor bit rates and achieving higher bandwidth.

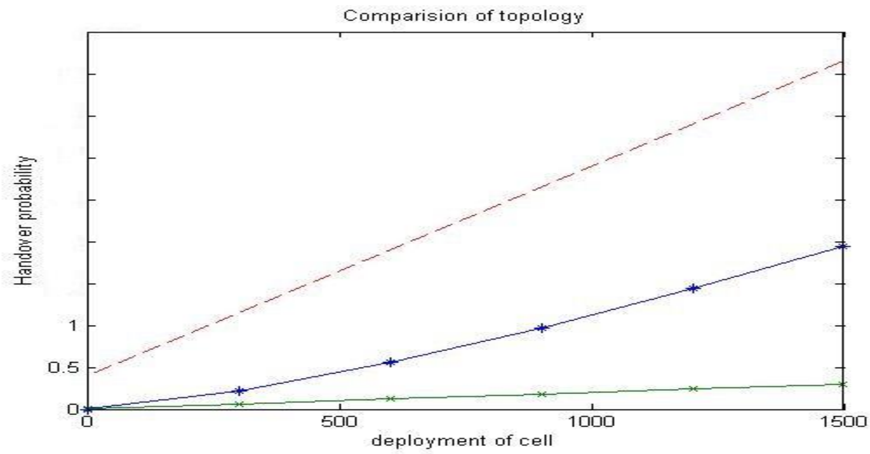
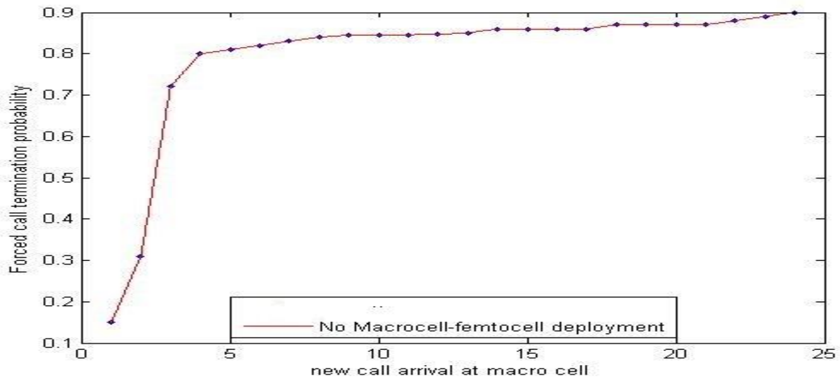


Fig 4: Probability Handover Comparison



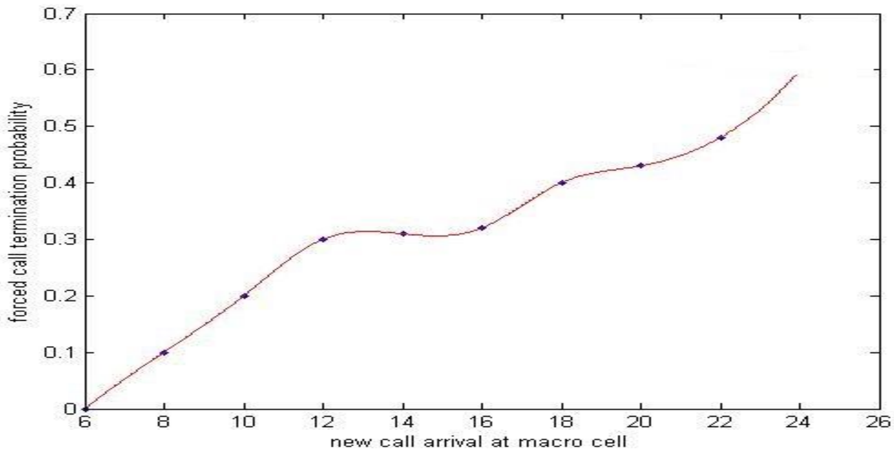


Fig 5 & 6: Forced Call termination for Macro cell network

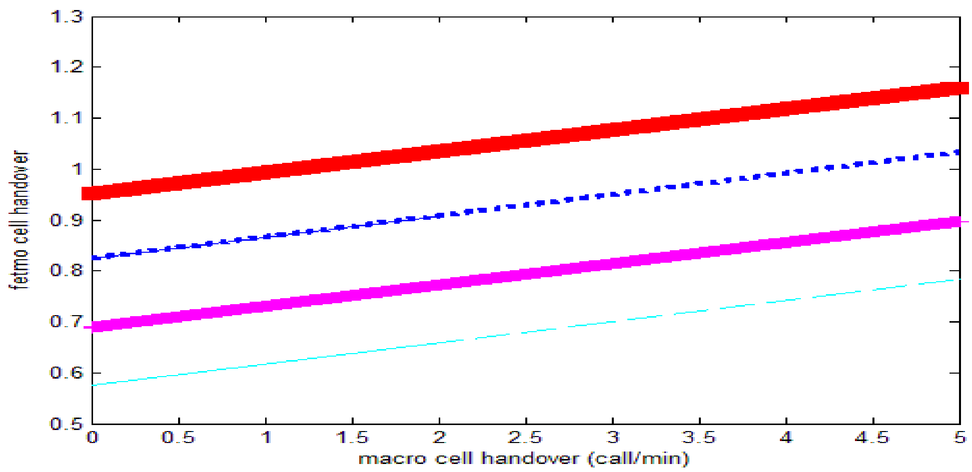


Figure 7: Macro cell to Fetmo cell call availability at different probability

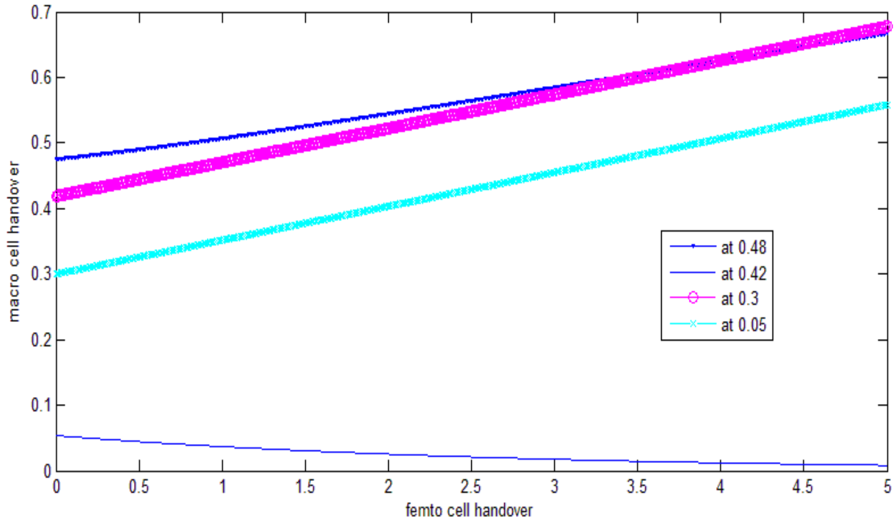


Fig 8: Fetmo cell handover vs macro cell handover arrival

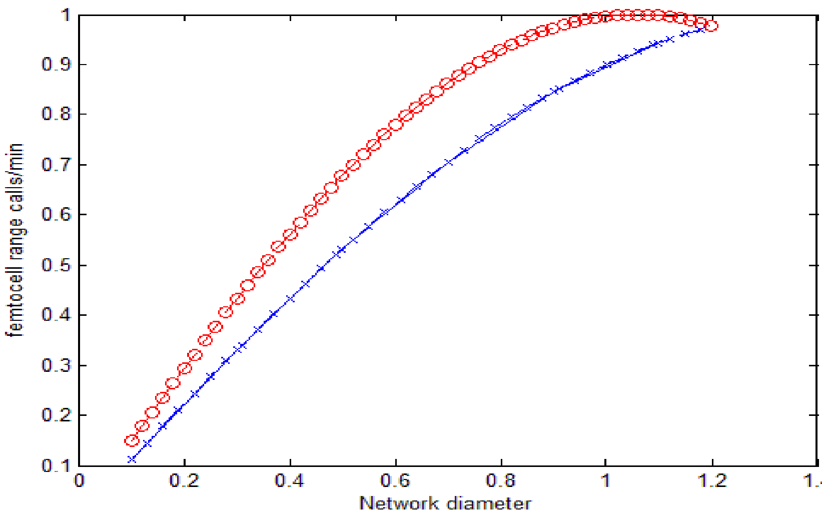


Fig 9: Call dropping rate with change in cell diameter to femto cell

Table 1. Condensed form of the analysis parameters

Concerned Mainly with Parameters	**Values Estimated**
Area covered by a femtocell in terms of its radial extent	15 (m)
Frequency of femtocell carriers	2 (GHz)
Powerful signal transmission via macrocellular BS	1.8 KW
Power level of a FAP's maximum transmission	12 (mW)
Macroscopic BS Elevation	110 (m)
Altitude of the FAP	2.3 (m)
MS at its peak	2.2 (m)
aFAP's minimum acceptable received signal strength (RSSI) for call establishment	-85.8(dBm)
Potential Macrocell Bandwidth (C)	9 (Mbps)

Non-adaptive Quality of Service call bandwidth requirements and allocations	72 (Kbps)
Optimal data transfer rate for each of the QoS-adaptive calls	64 (Kbps)
QoS-adaptive calls have a minimum bandwidth requirement and allocation	32 (Kbps)
proportion of visitors (QoS non-adaptive calls: QoSadaptive calls)	1:1
Distribution of microcells in terms of the number of deployed femtocells	950
When all calls are averaged together, the average duration is (1/Γ) second	2 Minutes or 0.033 Hr
The typical length of a femtocell phone call is 1 second (1/ψf)	6 Minutes or 0.1Hr
Time taken for a microcell to have an average conversation (1/ψm)	4 Minutes or 0.066 Hr
Average number of calls per hour (femtocell coverage area: macrocell only coverage area)	25:1
Statistical Dispersion of the Lognormal Shadowing Loss	10 dB
Reduction in Penetration	18dB

5. Conclusion

The technology of the femtocell is one of the most promising enabling technologies for fourth-generation and fifth-generation wireless communication. It is possible to divert some of the traffic that would normally flow through the macrocellular infrastructure, which will allow for an improvement in the capacity of the cellular network. The integration of femtocells and macrocells into a single network presents an intriguing opportunity for the development of future convergence networks. It has the ability to dramatically increase the quality of service provided to indoor customers at a far more affordable cost. Within the coverage region of a macrocell, the proposed CAC policy makes it possible for significant numbers of calls to be handed over. The utilisation of a traffic model in conjunction with an integrated network of macrocells and femtocells enables very accurate performance measurement. The findings of the study provide a concrete illustration of the benefits associated with the recommendations made.

REFERENCES

[1] P. Sule and A. Joshi, "International Journal of Computer Science and Mobile Computing Architectural Shift from 4G to 5G Wireless Mobile Networks," 2014. [Online]. Available: www.ijcsmc.com

[2]M. Z. Chowdhury and Y. M. Jang, "Handover management in high-dense femtocellular networks," EURASIP J WirelCommunNetw, vol. 2013, no. 1,2013, doi: 10.1186/1687-1499-2013-6.

[3]H. Claussen, L. T. W. Ho, and L. G. Samuel, "An overview of the femtocell concept," Bell Labs Technical Journal, vol. 13, no. 1. John Wiley and Sons Inc., pp. 221–245, 2008. doi: 10.1002/bltj.20292.

[4]F. A. Cruz-Pérez and L. Ortigoza-Guerrero, "Flexible resource allocation strategies for class-based QoS provisioning in mobile networks," IEEE Trans VehTechnol, vol. 53, no. 3, pp. 805–819, May 2004, doi: 10.1109/TVT.2004.827152.

[5]M. Z. Chowdhury and Y. M. Jang, "Call Admission Control and Traffic Modeling for Integrated Macrocell/Femtocell Networks."

[6] GPP TS 32.500, Telecommunication management; self-organizing networks (SON); concepts and requirements (2011)

[7] H Jo, C Mun, J Moon, J Yook, "Self-optimized coverage coordination in femtocell networks". IEEE Trans. Wirel. Commun. 9(10), 2977–2982 (2010)

[8] FA Cruz-Perez, L Ortigoza-Guerrero, "Flexible resource allocation strategies for class-based QoS provisioning in mobile networks''. IEEE Trans. Veh. Technol. 53(3), 805–819 (2004)

[9] S. Das, T. E. Klein, K. K Leung, S. Mukherjee, G. Rittenhouse, L. G. Samuel, H. Viswanathan, and H. Zheng, "Distributed Radio Link Control Protocol Facilitating Fast Cell Site Selection in an All-IP Cellular Network," Proc. IEEE 62ndVeh. Technol. Conf. (VTC Fall '05) (Dallas, TX, 2005), vol. 3, pp. 1692–1696.

[10] F. J. Mullany, L. T. W. Ho, L. G. Samuel, and H. Claussen, "Self-Deployment, Self-Configuration: Critical Future Paradigms for Wireless Access Networks," Autonomic Communication: First Internat. IFIP Workshop, WAC 2004, Berlin, Ger., Oct. 2004: Revised Selected Papers (Michael Smirnov, ed.), Lecture Notes in Computer Science (LNCS), Vol. 3457, Springer, Berlin, Heidelberg, New York, 2005, pp. 58–68.

[11] C. E. Shannon, "A Mathematical Theory of Communication," Bell Sys. Tech. J., 27:3 (1948), 379–423 and 27:4 (1948), 623–656

[12] H. Claussen, L. T. W. Ho, H. R. Karimi, F. J. Mullany, and L. G. Samuel, "I, Base Station: Cognisant Robots and Future Wireless Access Networks," Proc. 3rd IEEE Consumer Commun. and Networking Conf. (CCNC '06) (Las Vegas, NV, 2006), vol. 1, pp. 595–599.