A Review on Interference Mitigation Technique for Two Tier Macro-Femto Network

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Abstract- Due to the latest growth in the wireless communication technologies the traffic of mobile communication process is increased and changes in voice call to multimedia application like video call and voice messages. To complete the users demand higher transmission channels are deployed in the wireless communication like 4G LTE/LTE-A. In the proposed review paper different approaches are discussed in related study which deals with the interferences in the femto-macro co-existed heterogeneous wireless network.

Keywords- Long Term Evolution (LTE), heterogeneous network, femtocell

I. INTRODUCTION

The conventional cellular network makes the use of macro-centric cell planning where only the macrocell base stations cover the network. Such cellular network based on macrocell is known as homogeneous network. In this network every base station has same transmit power, same antenna height, receiver noise, antenna pattern and same connection to the core network [1]. But the cellular network using macrocell base station may faces many challenges like degradation in coverage area and capacity of edge users. This problem is solved if transmitter come close to receiver but this is not economically feasible in macro-centric network. A more reliable and scalable solution is needed for mobile operators to improve network performance. Heterogeneous Network is solution considered by the mobile operators. Heterogeneous Network improves the network performance in cost efficient manner. Heterogeneous Network corresponds to a multi-tiered cellular network where the homogeneous network is embedded with additional network which is smaller than existing and low powered and short range base station i.e. small cells. Two tier heterogeneous network macrocell in first tier and embedded with small cell in second tier. Among all the small cells, femtocells or HeNBs are of great interest and significance to mobile operator [2]. Studies show that 50% of the voice traffic and 70% of the data traffic is driving from indoor users. The definite way to increase the capacity and coverage of the network is closeness of transmitter and receiver that is distance between the transmitter and receiver should be small [3].

II. RELATED STUDY

KrantiShrirangBhoite et al. in [1] have proposed a new approach for uninterrupted handover between the macrocell and femtocells. Two factors to be achieved in for better handover; first one is seamless handover and second is fast handover. Call admission policy is used for successful handovers. Three handover cases are to be taken, First is Hand in which is from macrocell to femtocell, Second is Hand off which is from femtocell to macrocell and Third is Inter-FAP which is in between two femtocells. This proposed work improves the femtocell utilization and number of handover is also decreased. AleksandarIchkov et al. in [2] have proposed the two-tier heterogeneous network which composed of multiple base stations. This LTE network consists of macrocell and femtocell. Heterogeneous network faces lots of challenges like reduced network capacity and efficiency. This paper proposed Radio Resources Management techniques to improve the above mentioned problems. Matlab is used to simulate the result in terms of network capacity and efficiency. By effectively utilizing the resources to macro and femto cell, the performance of congested network is improved. The proposed femtocell hybrid access increases the data rate upto 20 times for the users who are authorized as compared to the users who are not authorized.

O. Akinlabi et al. in [3] have discussed about femtocells advantages in improving the coverage area. Now a day's femtocells are also used for power saving function. Renewable energy sources can be used to power the femtocells. So, with improving the coverage area, femtocell can also reduce the cost of the cellular network by saving the energy. There are lots of advantages of using renewable energy as it is environment friendly, economically beneficial, stable energy prices and sustainable electricity. Matlab is used to simulate the results. The result shows the reduction in the cost, energy consumption and carbon emission by the use of renewable energy powered home appliances and femtocells. Rand Hussein Raheem et al. in [4] have discussed about mobile computing. The main aim of user is to be connected to the

internet when they are travelling from one position to another position (in trains and buses) with their mobile devices. Ergodic capacity, signal strength, spectral efficiency and throughput may reduce when outdoor Base Station provides coverage to User equipment travelling in trains and buses. To lessen the Path loss and Vehicular Penetration Loss (VPL), this paper proposed to use of mobile and fixed Femtocell technology. This paper discussed about three links: First link is Backhaul link which is in between the eNB transmitter and selected Fixed-Femto/Mobile-Femto, Second link is Direct link which is in between eNB and UEs and Third link is Access link which transmit the data from UEs to Femtocell and vice versa. A Scheduling algorithm is also used for scheduling process and Physical Resource Block distribution among Femtocell in Macrocell and UEs in macrocell.. The comparison has been made by comparing the performance in terms of Ergodic capacity, spectral efficiency, throughput and SINR. The comparison shows the improvement in all the parameters after implementing Mobile-Femto.

JoydevGhosh et al. in [5] have proposed a analytical framework of influence of the Femto base Station in dual tier system which constituted of macro base station. This dual tier system, were femtocell and macrocell both are present; network has to face some challenges. Uncoordinated installment of the femtocells causes destructive interference to macrocells and vice versa. By utilizing the spectrum optimally, the throughput of the macrocells and femtocells increases. By incorporating the Steerable beamforming, quality of service is further improved. The beamformer controls the amplitude, phase and direction of the signal to make the transmission directional. Rand Raheem et al. in [6] have presented interference problems suffered by the Base Station in LTE cellular network. Vehicular user equipment may suffer because of poor signal strength. Mobile Femtocell is the solution for vehicular User Equipment performance by decreasing the path loss, penetration loss and increasing the data rate and signal strength. But there are lots of challenges in deploying the Femtocell due of shortage of spectrums. This shortage results in interference between Macrocells and Femtocells as well as two Femtocells. The cell edge users suffer most because of this interference. The author discussed two solutions: Firstly to control the transmitted power and Secondly optimize the Base Station sharing in the network. Frequency reuse scheme is also proposed in worst case. The frequency reuse scheme also enhances the quality of the connection between the User Equipment and serving Base Station.

FouratHaider et al. in [7] have proposed a scheme to enhance the energy and spectral efficiency for mobile femtocell. Mobile femtocell gives better coverage in vehicles like buses and trains. The energy efficiency can be increased by using the non-orthogonal scheme. The spectral efficiency can also be increased by non-orthogonal partitioning scheme. According to this scheme, the spectrum is shared between the Base Station and Mobile Femtocells. Comparison has been made between the orthogonal transmission scheme and non-orthogonal scheme. This paper also determined he reduced signalling overload, improved signal strength using mobile femtocells. Anwesha Mukherjee et al. in [8] have proposed a frequency allocation scheme for macro-femtocell and micro-femtocell cluster-based network to mitigate the interference. In this scheme the two tier network is divided into a number of clusters. In each cluster we have a macrocell or microcell with femtocell deployed in it. Each microcell and macrocell is separate into three regions. Different frequencies are given to macrocell and femtocells in a macro-femtocell cluster. In the same way different frequencies is given to the microcell and femtocell in the micro-femtocell cluster. The results are determined in terms of signal-to-interference-plus-noise ratio and spectral efficiency. Signal-to-interference-plus-noise ratio can be increased to 62–92% by using the proposed scheme. The power transmission is reduced to 48%.

Rand Hussein Raheem et al. in [9] has analyzed the performance of cell edge users who have always suffered from poor signal strength and degraded Quality of Service. The main aim of user is to be connected to the internet when they are travelling from one position to another position (in trains and buses) with their mobile devices. The performance of the cell edge users are evaluated in terms of spectral efficiency, number of handovers, Signal to Noise ratio and Signal to Interference ratio. This paper presents the two cases: Mobile users with Fixed Femtocells and mobile users with Mobile Femtocells. Proportional Fair (PF) Scheduling algorithm is also used for scheduling process and distribution of Physical Resource Blocks. Matlab based dynamic level system simulator is used to determine the results. The comparison has been made between Mobile Femtocell and Fixed Femtocells. The comparison shows the improvement in all the parameters after implementing Mobile-Femtocells. RocíoAcedo-Hernández et al. in [10] have presented a cost-efficient way out that gives sufficient coverage in buildings that is small cell system. An algorithm stands on clustering method is proposed in this paper. This algorithm determines base station, radio heads and the number of antenna needed for indoor area. Thus this clustering algorithm many radio heads of different houses or buildings in one Base station unit and this clustering the radio heads reduce the deployment costs. In this paper, authors discuss about the two stages, in a primary dimensioning step, the algorithm approximate the necessary essentials in all building. Later in the second step, the algorithm seems for the deployment of the small cell with least cost by allocating different buildings or houses into the one Digital Unit. The performance is determined in terms of capacity, coverage and cost. The total network cost is reduced by 49% using proposed clustering algorithm.

KonstantinosDimou et al. in [11] have presented a 3GPP LTE system to propose considerably better throughput, good handover performance and higher data rates. Handover is important parameter for overall performance of cellular network. In this paper, author determined the performance of handover by the means of Handover failure rate and delay in handover. A system level a simulator is used within usual urban environment. This urban environment contains many User Equipments (40 and 100 per cell) travelling at different speed, different cell radius and different traffic load. All these parameters affect the Handover Failure. Good performing handover procedure can be obtained by using Handover triggering mechanism. According to simulation result, it is noted that handover failure rate for 1 km cell radius, the User Equipment having the speed of 120 kilometer per hour lies between 0 to 2.2% in high traffic. And handover failure rate for the medium and low traffic is within range of 0 to 1.3%.
Anna Dudnikova et al. [12] have presented a self-optimized coverage function for two tier femto-macro cell arrangement. Femtocell provides the coverage to the areas like buildings, malls and airports. This proposed model reduces both the interference and power consumption. While the traffic is low in network, this model put some of the femtocell base station into the listen mode. And hence by doing this, power consumption can be reduced by 48.29%. When the traffic is high in network, femtocell base station creates high capacity zone. This scheme enhances the capacity and offloads the excess traffic from macrocell and with this it also mitigates the co-channel interference.
Ponnu Jacob et al. in [13] have proposed orthogonal circular polarized transmission for macro-femto network. Two tier networks consist of macrocell embedded with low power and small range femtocell. This network increases the coverage area but at the same time faces lots of challenges like cross-tier interference which finally decrease the performance of the system. To overcome this cross polarization is proposed in this paper which enhances the spectral efficiency of the network. A single channel is used to transmit the information but both the femto and macro uses the different polarization. Femtocell uses right hand circular polarization and macrocell network uses of left hand circular polarization for transmitting the signal. The orthogonal polarization helps both the cell using the same frequency without any interference. Rand Hussein Raheem et al. in [14] have presented a solution to the vehicular users which get small bandwidth and poor signal strength as they move away from the eNB. These users at cell edge may suffer from path loss and fading. Femtocell technology is the solution of above mentioned problem. This technology made an indirect link between user equipments and eNB with the help of the Femtocell. By using the Mobile Femtocells one can achieve larger coverage area at high Vehicular Penetration Loss. Comparison has been made in between Mobile Femtocell and Fixed Femtocell. The result is achieved by MATLAB simulator and the result showed that the performance of Mobile- Femtos is way better than Fixed-Femtosin the cellular network with proposed Handover schemes. This paper discussed the performance in term of drop calls, block calls, throughput and outage probability.
Shiqi Xing et al. in [15] have presented a platform where we simulate the two tier system; first one is Macrocell and second is Femtocell. Femtocell is used to increase the capacity signal strength, signal quality and coverage area. Femtocell may also save the battery life of the mobile equipment as now User Equipment does not communicate the Base Station directly. This simulation model uses the parameters of 3GPP named LTE-Sim. This paper compares the performance of the macrocell and femtocell in terms of the traffic load and position and number of buildings and Base Station. For the better use of femtocell technology, concept of Fractional Frequency Reuse can also be added. The result of simulation shows the good performance using Femtocell instead of Macrocell and better performance when Fractional Frequency Reuse was implemented in terms of Signal to Noise ratio.

Inferences from Literature Review

Author's Name	Year	Technology/Algorithm	Conclusion
Kranti et al.	2018	Macro Cell Network	Call admission policy is used for successful handovers. Three handover cases are to be taken, First is Hand in which is from macrocell to femtocell, Second is Hand off which is from femtocell to macrocell and Third is Inter-FAP which is in between two femtocells. This proposed work improves the femtocell utilization and number of handover is also decreased.
Aleksander et al.	2017	Resource Allocation and proactive offloading	This paper proposed Radio Resources Management techniques to improve the above mentioned problems. Matlab is used to

			simulate the result in terms of network capacity and efficiency
Akinlambi et al.	2017	LTE networks	The result shows the reduction in the cost, energy consumption and carbon emission by the use of renewable energy powered home appliances and femtocells.
Rand et al.	2017	Scheduling Algorithm	A Scheduling algorithm is also used for scheduling process and Physical Resource Block distribution among Femtocell in Macrocell and UEs in macrocell. The comparison has been made by comparing the performance in terms of Ergodic capacity, spectral efficiency, throughput and SINR.
Joydev et al.	2017	Macro cell network	By utilizing the spectrum optimally, the throughput of the macrocells and femtocells increases. By incorporating the Steerable beamforming, quality of service is further improved.
Raheem et al	2016	Femto cell in LTE Networks	The author discussed two solutions: Firstly to control the transmitted power and Secondly optimize the Base Station sharing in the network. Frequency reuse scheme is also proposed in worst case. The frequencyreuse scheme also enhances the quality of the connection between the User Equipment and serving Base Station.
Fourat et al.	2016	Mobile Femto Cell	The spectrum is shared between the Base Station and Mobile Femtocells. Comparison has been made between the orthogonal transmission scheme and non-orthogonal scheme. This paper also determined he reduced signalling overload, improved signal strength using mobile femtocells.
Anwesha et al.	2016	Frequency Allocation scheme	In this scheme the two tier network is divided into a number of clusters. In each cluster we have a macrocell or microcell with femtocell deployed in it.
Rand Hussein et al.	2016	Fixed and mobile Femto cells	The main aim of user is to be connected to the internet when they are travelling from one position to another position (in trains and buses) with their mobile devices. The performance of the cell edge users are evaluated in terms of spectral efficiency, number of handovers, Signal to Noise ratio and Signal to Interference ratio.
Rocio et al.	2016	Clustering Method	This algorithm determines base station, radio heads and the number of antenna needed for indoor area. Thus this clustering algorithm many radio heads of different houses or buildings in one Base station unit and this clustering the radio heads reduce the deployment costs.
Konstantinos et al.	2016	3 G LTE approach	Presented a 3GPP LTE system to propose

			considerably better throughput, good handover performance and higher data rates. Handover is important parameter for overall performance of cellular network. In this paper, author determined the performance of handover by the means of Handover failure rate and delay in handover.
Anna et al.	2015	Coverage function	This proposed model reduces both the interference and power consumption. While the traffic is low in network, this model put some of the femtocell base station into the listen mode. And hence by doing this, power consumption can be reduced by 48.29%.
Ponnu et al.	2015	Orthogonal circular polarized transmission	To overcome this cross polarization is proposed in this paper which enhances the spectral efficiency of the network. A single channel is used to transmit the information but both the femto and macro uses the different polarization.
Rand Huseen et al.	2015	LTE Network	This technology made an indirect link between user equipments and eNB with the help of the Femtocell. By using the Mobile Femtocells one can achieve larger coverage area at high Vehicular Penetration Loss.
Shiqi et al.	2014	3GPP approach	This paper compares the performance of the macrocell and femtocell in terms of the traffic load and position and number of buildings and Base Station. For the better use of femtocell technology, concept of Fractional Frequency Reuse can also be added.

III. CONCLUSION

The quality, coverage and services of the wireless sensor networks are improved by using Femto cells. These cells are economic and supported by the argument of improved indoor coverage of consumers and substantial cost savings for operators due to capacity offload. The bandwidth factor is mainly affects the wireless links. Femto cells are the effective alternative method to divert the traffic from the base station. The only issue in the wireless system is to mitigate interferences which creates challenges in customer satisfaction.

IV. REFERENCES

[1]. KrantiShrirangBhoite, SachinGengaje, "Handover Management in Two-Tier Femtocell- Macrocell Network", Wireless Personal Communication, Springer, Vol. 98, No. 3, pp. 2849–2866, February 2018.

[2]. AleksandarIchkov, Vladimir Atanasovski, LiljanaGavrilovska, "Analysis of Two-Tier LTE Network with Randomized Resource Allocation and Proactive Offloading", Mobile Networks and Applications, Springer, Vol. 22, No. 5, pp. 806 - 813, October 2017.

[3]. Rand Raheem, AboubakerLasebae, Mahdi Aiash, Jonathan Loo, "Interference Management for Co-Channel Mobile Femtocells Technology in LTE Networks", IEEE 12th International Conference on Intelligent Environments, pp. 80-87, October 2016.

[4]. O. Akinlabi, Meera K. Joseph, "Using Renewable Energy Sources for Power Saving: Home Appliances and Femtocells", Procedia Manufacturing, Elsevier, Vol. 7, pp. 27-33,2017.

[5]. Rand Raheem, AboubakerLasebae, Mahdi Aiash, Jonathan Loo, Robert H. Colson, "Mobile FemtocellUtilisation in LTE Vehicular Environment: Vehicular Penetration Loss Elimination and Performance Enhancement", Vehicular Communications, Elsevier, Vol. 9, pp. 31-42, July 2017.

[6]. JoydevGhosh, Sanjay Dhar Roy, "The Implications of Cognitive Femtocell Based Spectrum Allocation Over Macrocell Networks", Wireless Personal Communication, Springer, Vol. 92, No. 3, pp. 1125–1143, February 2017.

[7]. FouratHaider, Cheng-Xiang Wang, Bo Ai, Harald Haas, ErolHepsaydir, "Spectral/Energy Efficiency Tradeoff of Cellular Systems With Mobile Femtocell Deployment", IEEE Transactions on Vehicular Technology, Vol. 65, No. 5, pp. 3389 - 3400, May 2016.

[8]. Anwesha Mukherjee, Debashis De, Priti Deb, "Interference management in macrofemtocell and micro-femtocell cluster-based long-term evaluation-advanced green mobile network", IET Communicaion, Vol. 10, No. 5, pp. 468 - 478, April 2016.

[9]. Rand Hussein Raheem, AboubakerLasebae, Mahdi Aiash, Jonathan Kok-Keong Loo, "Performance Evaluation of Mobile Users Served by Fixed and Mobile Femtocells in LTE Networks", Journal of Networking Technology, Vol. 7, pp. 16-33, March 2016.

[10]. RocíoAcedo-Hernández, MatíasToril, Salvador Luna-Ramírez, Carlos Úbeda and MaríaJosefa Vera, "Automatic Clustering Algorithms for Indoor Site Selection in LTE", EURASIP Journal on Wireless Communications and Networking, Springer, No. 1,March 2016.

[11]. KonstantinosDimou, Min Wang, Yu Yang, MuhammmadKazmi, Anna Larmo, Jonas Pettersson, Walter Muller, YlvaTimner, "Handover within 3GPP LTE: Design Principles and Performance", IEEE Vehicular Technology Conference, pp. 1-5, January 2016.

[12]. Anna Dudnikova, Daniela Panno, Antonio Mastrosimone, "Measurement-Based Coverage Function for Green Femtocell Network", Computer Networks, Elsevier, Vol. 83, pp. 45-58, June 2015.

[13]. Ponnu Jacob, A.S. Madhukumar, A. Alphones, "Orthogonal Circular Polarized Transmission for Interference Control in Femto–Macro Networks", Journal of Computer Communications, Elsevier, Vol. 58, pp. 70-81, March 2015.

[14]. Rand Hussein Raheem, AboubakerLasebae, Mahdi Aiash, Jonathan Kok-Keong Loo, "Mobility Management in LTE/Mobile Femtocell Networks: Outage Probability and Drop/Block Calls Probability", Enterprise-Resource-Planning-Systeme-Sommersemester, January 2015.

[15]. Shiqi Xing, PanthaGhosal, ShoumanBarua, Ramprasad Subramanian, KumbesanSandrasegaran, "System Level Simulation for Two Tier Macro-Femto Cellular Networks", International Journal of Wireless & Mobile Networks, Vol. 6, No. 6, pp. 1-14, December 2014.