Various Handover Techniques for Heterogeneous Networks: A Survey

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Abstract **-** In the latest trend the wireless communication channel users move between heterogeneous networks using terminals. The different real time and non-real time multiple interfaces are used for connection. In fourth generation wireless networks vertical handover decision algorithms plays an important role for providing quality of service in applications. This paper presents the review on handover algorithms and their requirements. The table given in paper represents the different approaches and their outcomes.

Keywords **-** *Long Term Evolution- Advanced (LTE-A), vertical handover, Heterogeneous Networks (HetNets).*

I. INTRODUCTION

Mobile networks have seen an uninterrupted growth in the last decades. The GSM technology like GSM, GPRS, EDGE and UMTS has more than 3.3 M subscriptions in 2008. Due to high traffic and more demand of data rate wireless communication has to be given support to high speed internet services, multimedia. So after 2G and 3G, LTE came forward. Long –Term Evolution is 3GPP (third generation partnership project) IP based OFDMA (Orthogonal Frequency Division Multiple Access) technology [1]. LTE provides low latency, very fast speed and increases the capacity. Data traffic has increased to 30 times between 2010 and 2015 and more than 4 billion 3GPP wireless subscriptions will be operating in the network [2]. Today 60% of voice and 70% of traffic generated indoors. To provide proper coverage and increase throughput in the indoor 3GPP LTE-A small cells are deployed like femto, pico and micro cells. These cells formed two tier LTE Heterogeneous Networks. Macro cell is called eNB and femto cells are called HeNB or femto cells. Mobility management is the main challenge for these networks. For the proper management of mobility handovers should be there in LTE-A HetNets. There are femto-macro, macro-femto and femto-femto handovers are possible in LTE-A HetNets. The vertical handover technique is used to reduce the unnecessary handovers by using the speed of user equipment and its trajectory. Heterogeneous networks increases reliability of the overall communication system [3].

II. HANDOVER

Handover refers to the process of transferring an active call from one cell in a cellular network to another cell. Handover is also defined as when a call is transferred from one channel to another channel in a cell. Different types of handover techniques are considered like horizontal and vertical handover. Depending on the requirements user equipment will select the particular handover method. Fig. 1.1 shows the classification of handover methods. The handover methods can be used between two same networks or it can be used between two different networks. To reduce the packet loss during handovers there should not be unnecessary handovers.

A) Hard Handover

In this the radio link to the previous base station is released and then the radio link to the new base station is established. It means by using hard handover, a mobile terminal is allowed to make a connection with only one base station at a particular time [4].

B) Soft Handover

In this handover a mobile terminal makes a radio link with no less than two base stations in overlapping handover region and it first makes a connection with new target base station then release the connection with the previous base station [4]

III. RELATED STUDY

M. Mujtaba Shaikh et al. in [1] have discussed that the joint downlink and uplink distribution in two tier Het Nets has been studied by taking into account the power control mechanism in uplink. User select its nearest BS or to the BS whose received power is maximum in the downlink. The author has evaluated spectral efficiencies, marginal uplink and marginal downlink probability by using LTE simulator with the help of adaptive modulation. After simulations it has been shown that the symmetrical spectral efficiency is enhanced under average association. Also it shows when user is associated with BS with large power in the DL, avoid the criteria of power control, maximum SE is achieved.

Maissa Boujelben et al. in [2] have discussed that 4G and 5G are increasing very fast to meet user's demand. Cost becomes an issue due to the small cells that are deployed to increase the coverage and capacity of the network. The author has presented a model for an OPEX (Operational Expenditure) cost and CAPEX (Capital Expenditure) cost for user's networks. Then again a model is presented for LTE HetNets dependent on green self-optimization module for handover whose main goal is to decrease the cost of consumption of energy for the network. The main criteria is self-configuration and self-healing. It occurs because the offloaded cells are switched off. Simulations show that the proposed model generate better results when the users of the mobile moves with very low speed like in dense areas. This

method helps in the saving of upto 80%of consumption of energy.

Tugçe Bilen et al. in [3] have discussed that ultra-densification handle large data traffic in coming 5G networks because small cell eNBs are deployed in large quantity. It may result in unwanted, frequent handovers and also causes the delay in handover. The author has proposed a mobility and management of handover strategy based on Markov chain and SDN for 5G networks. The goal of this scheme is to select and allocate the optimal eNBs of the mobile nodes to the Open Flow tables. Handover delays of the proposed and conventional handover schemes are calculated on the basis of dissimilar values of densification ratio to evaluate level of densification for comparison. Simulations show that handover delays and failures in proposed strategy are reduced by 52 and 21 % in comparison with conventional scheme.

Li Quiang et al. in [4] have represented user focused scheme for handover for combined 5G networks that helps in achieving various objectives.. During handover maximum data rate received and less blockage probability should be achieved. Whenever the user has to do handover he has to calculate both these parameters along with throughput for every BS available. By considering all these parameters multi objective problem is converted to maximization problem. The author has solved this problem to calculate how to select the network. This evaluation assures that according to the information of the environment available the user evaluate which BS is the best for handover by considering two features: maximum data rate and minimum blockage probability.

Sonal Jain et al. [5] have discussed that femtocells are becoming member of next generation 5G and wireless networks at small buildings and homes. With the help of Femtocells better coverage, high data rates and capacity can be enhanced of indoor user. When the Femtocells are deployed two kinds of interference occurs: between the two nearest femtocells or between macrocell and femtocell. For better utilisation of the band it is important to remove both the interferences. The author has proposed a scheme to remove interference between adjacent femtocells. The capacity of the cell can be increased by the deployment of six sector along with reduction in cochannel interference. It has been proved after the simulation that utility of spectrum will increase by using femtocells.

Yao Sun et al. in [6] have presented reinforcement learning based mechanism SMART for reducing the number of handovers in mm wave HetNets while maintaining user's (QoS) Quality of Services. After the handover conditions are met, User equipment have to select suitable target Base Station by using the algorithms SMART-M and SMART-S. SMART-M is used for multiple UE and SMART-S for specific UE. The author compared SMART handover policy with two policies: Rate-based handover (RBH) and SINR based handover policies. After simulations in MATLAB, it has been concluded that the number of handover can be reduced by 50% by using SMART as compared to two other policies while user's QoS is maintained.

S. M. Ahsan Kazmi et al. in [7] have discussed that the communication from device to device (D2D) is referred as promising method for increasing the throughput and spectral efficiency of the cellular networks while managing the interference. The choice of mode and distribution of resources for D2D network is taken into account along with maintaining the interference. Enhancement of utility of D2D is main problem recognized. The author has presented a learning framework dependent on Markov chain to solve this problem and evaluated transition probabilities. After this an algorithm (a novel two phase) is formed to select mode and distribution of resources. To minimise the calculations in the framework, two more algorithms are presented that are dependent on the theory of matching. Simulations shows that presented algorithm achieves performance gain of about 35% as compared with conventional algorithm.

Yao-Jen Liang in [8] has presented two tier network i.e. OFDMA having only one macro cell and large number of femto cells where each user can enter or leave its serving cell according to user mobility. An algorithm for the dynamic allocation of resources is proposed along with dynamic and static parts. Static algorithm is based on graph theory where femto cells are clustered by decreasing the interference. Each femto base station (FBS) provides sub-channels to femto user equipment (FUE). When there is no sub channel available and the FUE enters then it behaves as FBS a sub-channel ''pseudo-steals'' if possible. It has been proved that pseudo stealing algorithm that is proposed improve the throughput and reduce the outage probability for access of FUEs.

Olusegun O. Omitola et al. in [9] have discussed that in the cellular network to increase the capacity, small cells like femto cells are used and are best to increase the bandwidth and coverage of the network. But with the use of femto cells Mobile equipment faces the problem like handovers that are unnecessary, interference, power and security problems. The author has proposed the algorithm that reduces the number of unnecessary handover sand probability of call blocking. For the evaluation of an algorithm an event-driven simulator was formed in Visual Studio environment using C. There is a reduction of probability of call blocking by approximately 45% by using the proposed algorithm.

Yu Chen et al. in [10] to 5G networks. Instead of large band used the problem of capacity and coverage arises with the number of users increases. The author has presented a optimization scheme in which coverage as well as capacity is self-organised to increase them. It has been shown that the ratio of coverage for HeNB is very large as compared to static power transmitted in macro eNB case. When HeNets are densely spreaded the ratio of coverage is same as in -20dBm but when it is sparsely spreaded then the power which is optimised will be more than -20dBm. Hence the

presented scheme increases coverage and enhances capacity for 5G networks.

Xiaodong Xu et al. in [11] have proposed an analytical model for the HetNet to evaluate the cross-tier handover and derive expressions for rate of handover, ping-pong and handover failure that are dependent on TTT (Time to Trigger), user mobility and density of BS. The 3GPP handover (cross tier) take place from macro to small cell tier (M2S). When the UE travels from the coverage of macro to small cell, M2S handover is triggered and TTT timer is started. The handover failure rate decreases when thr TTT decreases while the ping-pong rate increases. After MATLAB simulations the accuracy of the analytical model is verified which helps in planning of the network and optimizations of handover in densely Heterogeneous Network

Pramod Goyal et al. in [12] have proposed a procedure to moderate the choices of static user based on real time in accordance with present value of respective handover decision features, to transfer them to dynamic. The consequence of Dynamic User Preferences to identify the best available network during handover (verticle) is calculated using Multi Attributes Decision Making technique in HetNets. MADM techniques mostly used are MEW, SAW, TOPSIS and GRA. After simulations in MATLAB, it has been concluded that the count of handovers that are vertical using dynamic user preferred weights is small as compared to static user preferred weights to finish an application by the mobile user for all MADM techniques.

Adnan Noor Mian et al. in [13] have presented that IEEE 802.11 protocol to evaluate the experiments under mobility. To calculate the efficiency of handover experiments are conducted on the basis of real mobile testbed. This testbed consists of three nodes. One is placed on the vehicle to calculate the effect of speed of vehicle on the 802.11 mechanism for handover. It has been analyzed that the speed of vehicle is not affecting the performance of handover mechanism. Calculations show that there are frequent handovers under mobility. It is ping pong effect in which hysteresis is not present in 802.11 protocols. To decrease the unwanted handovers the author suggested to perform experiments on the basis of real time on large scale that use link metric and also coupled with the hysteresis.

Silki Baghla et al. in [14] have discussed that the consumption of energy is the main problem in HetNets. The coming generation mobile users have a large number of interfaces to connect themselves by using one or more networks simultaneously. In HetNets there are vertical handovers. Vertical handovers helps in finding out which network is providing better services but consuming more energy during operation or handover. The author has proposed vertical handover scheme that is energy efficient based on VIKOR algorithm. It helps in decreasing the consumption of energy by using three interfaces: cellular, WIMAX and WLAN interface working at the same time. It also helps in the reduction of handovers as compared to selected optimum network.

Rami Ahmad et al. in [15] have proposed a handover scheme by applying two policies for two tier LTE networks, the method of moving direction prediction and the distance between location of HeNB and the current position of UE. The path of UE is used to guess its position in future and on the basis of these guesses target cell is selected. The proposed algorithm MDD VHD (Movement direction distance vertical handover) increases the performance of the system by reducing the handovers by 48%, the packet delay ratio by 91%, packet loss ratio by 86.2%, the average number of signalling measurements by more than 99% and throughput is improved by (15.3%) of the proposed algorithm as compared to Deswal algorithm.

Inferences from the Literature Review

Author's Name	Year	Technology/ Algorithm Used	Outcomes
Mujtaba et al	2017	Two-Tier Het Nets	The author has evaluated spectral efficiencies, marginal uplink and marginal downlink probability by using LTE simulator with the help of adaptive modulation.
Maissa et al	2017	Self-optimization Module	The author has presented a model for an OPEX (Operational Expenditure) cost and CAPEX (Capital Expenditure) cost for user's networks. Then again a model is presented for LTE HetNets dependent on green self-optimization module for handover whose main goal is to decrease the cost of consumption of energy for the network.
Tugce et al.	2017	Markov Chain and SDN	The author has proposed a mobility and management of handover strategy based on Markov chain and SDN for 5G networks. The goal of this scheme is to select and allocate the optimal eNBs of the mobile nodes to the Open Flow tables.
Li quiang et al.	2017	Multi-Objective Handover Scheme	The author has solved this problem to calculate how to select the network. This evaluation assures that according to the information of the environment available the user evaluate which BS is the best

			for handover by considering two features: maximum data rate and minimum blockage probability.
Jain et al.	2017	Femto Cells	The author has proposed a scheme to remove interference between adjacent femtocells. The capacity of the cell can be increased by the deployment of six sectors along with reduction in co-channel interference.
Yao Sun et al.	2017	Reinforcement Learning based Approach SMART	The author compared SMART handover policy with two policies: Rate-based handover (RBH) and SINR based handover policies. After simulations in MATLAB, it has been concluded that the number of handover can be reduced by 50% by using SMART.
S.M ahsan et al.	2017	Markov Chain Concept	The author has presented a learning framework dependent on Markov chain to solve this problem and evaluated transition probabilities. After this an algorithm (a novel two phases) is formed to select mode and distribution of resources.
Yao jen et al.	2017	OFDM and Dynamic Allocation Algorithm	An algorithm for the dynamic allocation of resources is proposed along with dynamic and static parts. Static algorithm is based on graph theory where femto cells are clustered by decreasing the interference.
Omitola et al.	2017	Enhanced Handover Algorithm	The author has proposed the algorithm that reduces the number of unnecessary handover sand probability of call blocking. For the evaluation of an algorithm an event-driven simulator was formed in Visual Studio environment using C. There is a reduction of probability of call blocking.
Yu Vhen et al.	2017	Optimization Approach for coverage	The author has presented a optimization scheme in which coverage as well as capacity is self-organized to increase them. It has been shown that the ratio of coverage for HeNB is very large as compared to static power transmitted in macro eNB case.
Xiaodong Xu et al.	2017	Cross-over Handover	Proposed an analytical model for the HetNet to evaluate the cross-tier handover and derive expressions for rate of handover, ping-pong and handover failure that are dependent on TTT (Time to Trigger), user mobility and density of BS. The 3GPP handover (cross tier) take place from macro to small cell tier (M2S).
Pramod et al	2018	Vertical handover Approach	The count of handovers that are vertical using dynamic user preferred weights is small as compared to static user preferred weights to finish an application by the mobile user for all MADM techniques.
Adnan et al.	2018	Handover Mechanism	It has been analyzed that the speed of vehicle is not affecting the performance of handover mechanism. Calculations show that there are frequent handovers under mobility. It is ping pong effect in which hysteresis is not present in 802.11 protocols.
Silki et al.	2018	Vertical Handover Approach	The author has proposed vertical handover scheme that is energy efficient based on VIKOR algorithm. It helps in decreasing the consumption of energy by using three interfaces: cellular, WIMAX and WLAN interface working at the same time. It also helps in the reduction of handovers as compared to selected optimum network.
Rami et al.	2018	Handover Mechanism	The proposed algorithm MDD VHD (Movement direction distance vertical handover) increases the performance of the system by reducing the handovers, the packet delay ratio, packet loss ratio, the average number of signaling measurements by more than 99% and throughput is improved by (15.3%)

IV. CONCLUSION

This paper presents a survey on the vertical handover in the wireless communication network. It shows the recent development in the field of handover and the algorithms used to enhance the performance of the devices on network. It represents the need of optimized architecture for handover decision making process. The goal of this paper is to find the effective method of handover according to the user demand.

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