

# Handoff Decision in LTE based Systems Using Simulated Maximum Likelihood Approach

Akash Deepak\*, Harsh Sardana\*\*, Hatesh Shyan\*\*\*

## ABSTRACT

Nowadays, the requirement for the applications having high data speed is increased in wireless networks, and the mobility of the mobile users also increases, LTE can support mobility up to 500km/h. LTE can provide better communication link between mobile user and the base station (eNodeB) and at this high speed the mobile user needs frequent handover, In this work we studied about various types of handovers used in cellular systems and LTE systems. also we have proposed a new method of handoff which is a combination of differential power and maximum likelihood estimate (MLE). At the end, results are shown in order to justify the efficacy of the proposed method.

**Keywords:** Handover, Hard Handover (HHO), Soft Handover (SHO) Semi soft Handover (SSHO), Differential Integrator Handover Algorithm using TTT window (DIHAT)

## 1. INTRODUCTION

Long-term evolution (LTE) is a current high-performance air interface comes under the third Generation Partnership Project (3GPP). 3GPP LTE is a merely packet-switched telecommunication technology with radio admittance which provides the outstanding service to 4G networks with less latency and higher data rate. Major objective of 3GPP is to fulfill the prerequisite of rapid information transportation medium as well as high capability of voice. The requirements of the forth coming generation of the networks require long term evolution having 100 Mbps of high throughput or for downlink it may be more and for uplink it is 50 Mbps. The main problem in long term evolution is lower latency and higher bit rate. Orthogonal frequency division multiple access (OFDMA) and multiple input multiple output (MIMO) are new and modified technologies which is developed by LTE physical layer where data and control data is transfer between eNodeB and the UE. OFDMA is usually developed for down linking, and OFDMA implementation is known as single carrier frequency division multiple access (SC-FDMA) is used in LTE for up linking with the motive to conserve power.

The Long-term evolution network composed of 2 major elements that are evolved UMTS terrestrial radio access network (E-UTRAN) and evolved packet core (EPC). Evolved packet core involves MME, SGW AND PGW. The mobility management entity is chief element that develops the signaling among the UE and core network. The protocols used by MME are known as NAS protocol (non-access protocol). The serving gateway executes data routing and forwarding among UE and eNodeB that moves locally for the data bearer when UE move within eNodeB. The packet data network gateway provides access to an exterior packet data network to UE by giving it an IP address. The evolved packet core is IP core network which can process with access of 3GPP radio and network without having access of 3GPP radio permits handover

\* (M.E Scholar), Chandigarh University, Email: akashthakursimpy@gmail.com

\*\* (Assistant Professor), Gharuan, Email: harsh1309@gmail.com

\*\*\* (Assistant Professor), Punjab, India, Email: cse.hatesh@gmail.com

process between and inside both the access types .eNodeB is the head module of UMTS terrestrial radio access network which executes radio operations related to interface like handoff and scheduling of packets. Via including the radio controller function, the air interface is given by eNodes with the abortion of user plane and control plane protocol regarding the UE, which reduces the latency and enhance the effectiveness. The Peak download rate of LTE depending on the user equipment category is 299.6 Mbit/s and a rate for uploading is 75.4 Mbit/s.

The LTE system has ability to maintain the cell sizes from radius 10 m (femto and picocells) to 100 km (62 miles) microcells radius. In the lower frequency bands, 5 km (3.1 miles) is the most favorable cell size that can be utilized in rural areas, where band of 30 km (19 miles) consists realistic performance and finally band with 100 km cell sizes supports satisfactory performance. Higher frequency band is used in urban area which is used to maintain the mobile broadband having high speed and cell size in this context can be 1km or less than 1 km. The LTE system may also help to maintain the mobility, demonstrated by terminals moving with 350 km/h (220 mph) or 500 km/h (310 mph) depending on the band of the frequency and it may enhance the spectrum scalability: where standardized wide cells are 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz

In the mobile communication network, handover may be determine as the method of sending data or it can be session of ongoing call from the source to target BS. It may also be referred as process of decision-making for handover that activates handover only when some specific situation is satisfied. Moreover, handover algorithm will trigger frequently unessential handovers which causing ping-pong effect. The situation for handover might differ over time because of the mobility of UE. Consequently, optimization of the parameters is of huge importance to confirm that how efficient and reliable the handoff algorithm is..A handover can mainly be classified in two categories: hard and soft handover. There will also another two system in handover that is inter and intra system handover.

### **1.1. Hard handover**

In hard handover, target cell channel is occupied and the source cell channel is released. Hence, the connectivity with the target cell is made and the connectivity between source cells will break before. Due to this reason it can be referred as the break-before-make. Hard handovers is sometimes good because it cannot waste the limited channels of the base stations.

#### ***1.1.1. Advantages of hard handover***

One of the important benefits is that as we know that it is a kind of handover process in which firstly the previous connection in break and than it will make connectivity with the another target base station, so there is less wastage of the resources(Base Stations/cell) and definitely cost is also reduced of the network.

#### ***1.1.2. Disadvantage of hard handover***

The main problem with this type of handover process if the device is fails to make connectivity with the target cell the call can be interrupted or sometimes it can be ended that time the device is not able to perform re-connectivity with the previous source base station because it already released the source base station.

### **1.2. Soft handover**

In the soft handover, source cell channel is preserved and utilized after until a new connection is made with the target base station, after getting service from the target base station the device can releases the previous channel or disconnect from the source base station. In soft handover the mobile device is able to maintains connectivity with more than 3 base station at same time..

### ***1.2.1. Advantage of soft handover***

Soft handover comes with many advantages but one of the main advantage is that there very less chance of data loss or call drop in soft handover because of its make before break functionality. Fading is also a king of property of the soft handover to increase the efficiency of the network. Moreover, soft handovers plays a major role in the very critical hardware were a single or may b multiple connection is needed all the time.

### ***1.2.2. Inter System and Intra System Handover***

Inter system handoff can be defines as the process in which when a person performing a call and during the calling it can controlled by an MTSO, but whenever it needs handover and when handover request in complete and now the control is shifted to the another MTSO, means all the controlling process is in the hand of another MTSO this process is the inter system handover. In inter system handover different MTSO's works, but in Intra system handover same MTSO is works during the ongoing calls or other communication processes. There is no change in MTSO during the calling process. All the controlling process is in the hand of the same respected MTSO

### ***1.2.3. Semi Soft Handover***

Semi soft handover is a integrated handover which can have both the property of soft and hard handover, as per the situation one kind of handover is perform either it is HO or SO. for example: in HO it is the process in which the previous connection is break firstly and then a new connection is establish, but is there is a little bit more delay in shifting the handover request, there will be a chance of data loss or termination of call too, so in this case SSHO is switch the property of soft handover in which the mobile device preserve the previous connection until it get connected to the new one. On the other hand the property of HHO is used when a person uses the data connection because while using data connection there is very few chance when a person feel the delay of micro seconds during the handover process.

## **2. RELATED WORK**

*Nie, Shiwen, Di Wu, Ming Zhao, XinyuGu, Lin Zhang, and Liyang Lu* et al. [1] proposed an Estimation technique for improved State of Mobility depending on the Handoff Optimization Algorithm. This proposed approach is implemented in the LTE-A Self-organizing Network and depending on the EMSE particular Time-to-Trigger (TTT) and dynamic handover margin (HM)-adjusting in Self-organizing Network is merged. The proposed approach in context to the performance iscontrast with two other conventional approaches. The analysis of result demonstrates that in proposed self-optimized technique entire handover failure has a noticeable fall.

*Yang, Fang, Honggui Deng, Fangqing Jiang, and Xu Deng* et al [2] in this paper, high speed LTE railway environment is considered to propose an optimized handoff algorithm. In order to overcome the disadvantages in Long-term evolution networks, Hand over optimization method has been presented. The results indicate that the proposed algorithm has high success rate of handover and has less numbers of handover.

*Gao, Zhibin, Canbin Chen, Yujie Li, Bin Wen, Lianfen Huang, and Yifeng Zhao* et al [3] in this paper, a mobility load balancing algorithm has been presented depending on handover optimization in Long-term evolution network. Furthermore, a MLB technique has been considered which depends on handoff optimization. Comparison has been made of several algorithms using metrics load, Ping-Pong effect and throughput. The simulation result proves that the proposed algorithm decreases the load of cells which are highly loaded and overcome the Ping-Pong effect.

*Kwong, ChiewFoong, TeongCheeChuah, Su Wei Tan, and AyyoubAkbari Moghanjoughi* et al. [4] in this paper fuzzy handoff triggering approach is proposed for Long Term Evolution network. The

implementation result demonstrates that the presented approach minimizes the handovers which are inappropriate by 20% when comparison is made with fuzzy logic and standard LTE triggering scheme for handover.

*Kim, Wan, GiSeok Park, and Hwangjun Song et al.* [5] presents a scheduling technique with a cross-layer packet design in this paper. By taking QoE states into consideration, UEs are allotted with resource of wireless network in this proposed algorithm. The proposed algorithm for handover maintains a balance state of QoE within the neighboring cells which is used to calculate the appropriate triggering time. At last, a simulation is done to evaluate the proposed system achievement. The Result analysis shows that presented cross-layer designed system improves the QoE states. It can be observed that the overall network utilization is better as compared with than other existing approaches.

*Nasri, Ridha, and Zwi Altman et al* [6] in this paper 3GPP LTE system by dynamic load balancing has been presented. In this work, auto-tuning of LTE mobility technique has been discussed. Each BS having handoff metrics radio load and the load of its neighboring cells is used to execute auto tuning. It helps to improve the cell congestion and balances the traffic and the load between cells .the performance of proposed algorithm indicates that the auto-tuning process carried out a significant gain in both call admission rate and user throughput.

*Hussein, YaseeinSoubhi, Borhanuddin M. Ali, MohdFadlee A. Rasid, A. Sali, and Ali Mohammed Mansoor et al.* [7] in this paper, a new optimized cell-selecting handoff for LTE system is presented and proposed a fuzzy multiple-criteria cell selection (FMCCS). Usage of RBs and selection criteria for user apparatus uplink situation considered under FMCCS. The result analysis indicates that proposed cell selection technique manage to reduce the effect of ping-pong and malfunctioning of handover. The performance indicates that the proposed techniques provide better results as compared with already existing technique.

*Boujelben, Maissa, Sonia Ben Rejeb, and Sami Tabbane et al.* [8] In this paper for LTE-A/5G HetNets systems a novel algorithm for handover is proposed which depends up on joint transmission scheme i.e. CoMP. The proposed technique has capability to reduce Inter Cell Interference (ICI). It can be seen from the performance of the proposed approach that it reduces the level of ICI and increase the mean throughput during Handoff per user.

*Chen, Kyung Tae Kim, Byungjun Lee and Hee Yong Youn et al* [9] new handover technique has been presented which increases the existing handover approaches. The proposed approach is depends on the two concepts i.e. lazy handover and early handover, which are used to avoid the effect of Ping-Pong and form an aging actual services. The performance indicates that the proposed techniques provide better results as compared with already existing technique.

### 3. PROPOSED METHODOLOGY

DIHAT is the process in which when a UE moves from one region to another, then firstly check the value of RSRP of both serving eNodeB and target eNodeB then compare the both values of RSRP, and there will be a point comes when  $RSRP(\text{Target eNodeB}) > RSRP(\text{Serving eNodeB})$ , that time TTT window is activated and run for a specific time interval for finding the values near to the selected threshold value and when it find some points which are very much similar to the selected threshold it can select the very nearest point and perform the handover, but one limitation is that the whole window is run after activating even it find some better values at the starting points of window, or there will be some chance that in whole TTT process at the time of starting it find some better value rather than the time of completion of the windows. so there will be chance of delay in the handover. TTT windows is activating after when  $RSRP(T) > RSRP(S)$ , but it doesn't mean that is the value of  $RSRP(T)$  is greater the mobile node needs handover, It is not only the matter of RSRP, Interference is also take under consideration for performing handover because some time RSRP is less and user could not face any disturbance in voice because interference is also very less and

sometimes RSRP is very high but user could not able to listen a single word from the other side due to the high interference. In the present approach two properties are used, first is the differential and other is the MLE algorithm to perform the handover, In this case firstly took some previous successful handover points and total number of handover request generated than apply the differential and MLE based Algorithm for performing the handover. MLE is a probability based technique in which firstly took the previous values of total number of handovers performs and the successful handovers and then apply the probability function on those values and find the value on which handover performs. In present technique no threshold value is used, simply the average rate of the successful handover values and values generated by the probability function of MLE handover point is declared. TTT window sometime take more time to decide the best value for handover, but the present technique will reaches at a point where handover point is better than the previous technique

### 3.1. Maximum Likelihood Estimation

Let us suppose a sample  $x_1, x_2, \dots, x_n$  of  $n$  independent and identically distributed observations, coming from a distribution with an unknown probability density function  $f_0(\cdot)$ . It is however surmised that the function  $f_0$  belongs to a certain family of distributions  $\{f(\cdot|\theta), \theta \in \Theta\}$  (where  $\theta$  is a vector of parameters for this family), called the parametric model, so that  $f_0 = f(\cdot|\theta_0)$ .

The value  $\theta_0$  is unknown and is referred to as the *true value* of the parameter vector. It is desirable to find an estimator  $\hat{\theta}$  which would be as close to the true value  $\theta_0$  as possible. Either or both the observed variables  $x_i$  and the parameter  $\theta$  can be vectors.

To apply the method of maximum likelihood estimation, one first specifies the joint density function for all observations. For an independent and identically distributed sample, this joint density function is

$$f(x_1, x_2, \dots, x_n | \theta) = f(x_1 | \theta) \times f(x_2 | \theta) \times \dots \times f(x_n | \theta)$$

Now we look at this function from a different perspective by considering the observed values  $x_1, x_2, \dots, x_n$  to be fixed “parameters” of this function, whereas  $\theta$  will be the function’s variable and allowed to vary freely; this function will be called the likelihood:

$$L(\theta; x_1, \dots, x_n) = f(x_1, x_2, \dots, x_n | \theta) = \prod_{i=1}^n f(x_i | \theta)$$

#### 3.1.1. Algorithm

The main aim of algorithm is to incorporate the RSRP differences of the source and target cell. The HO decision is made according to the triggering situation between the filtered RSRP differences and the triggering threshold and the maximum likelihood estimate.

1.  $FDIFs\_j(t) = (1-\alpha)$

2.  $*FDIFs\_j(t-1) + \alpha *DIFs\_j(t) (1)$

$$DIFs\_j(t) = RSRPT(t) - RSRPS(t) (2)$$

$DIFs\_j(t)$  is the RSRP measurement difference between the signalreceived of the eNodeB and the target NodeB at the time t.

3.  $FDIFs\_j(t)$  and  $FDIFs\_j(t-1)$  are the filtered  $DIFs\_j(t)$  and  $DIFs\_j(t-1)$  value at the t between the eNodeB and the neighboring cell j.

4. ‘ $\alpha$ ’ is known as the forgetting factor ( $0 \leq \alpha \leq 1$ ).

5. Calculate the Maximum Likelihood Estimate for all the FDIF (performance of the network)
6. MLE\_FDIFprobability is the HO triggering probability. If  $FDIFs\_j(t) > MLE\_FDIFprobability$ , Then the HO is triggered immediately. The  $FDIFs\_j(t)$  value is influenced by choosing of the  $\alpha$  value.
7. If the selected  $\alpha$  value equals or close to 1, it results in the  $FDIFs\_j(t)$  value more probably to be reflected by the most recent  $DIFs\_j(t)$  value.  
The value of the  $FDIFs\_j(t)$  will be very instant or responsive.
8. Else, if the selected  $\alpha$  value is equals or close to 0, it w results in the  $FDIFs\_j(t)$  value more probably to be reflected by the past  $FDIFs\_j(t)$  value.  
The value of the  $FDIFs\_j(t)$  would be very constant or unresponsive to the actual  $DIFs\_j(t)$  change.
9. The starting value of  $MLE\_FDIFs\_j(t-1)$  can be calculated either considering several early periods of  $DIFs\_j(t)$  values

#### 4. RESULTS

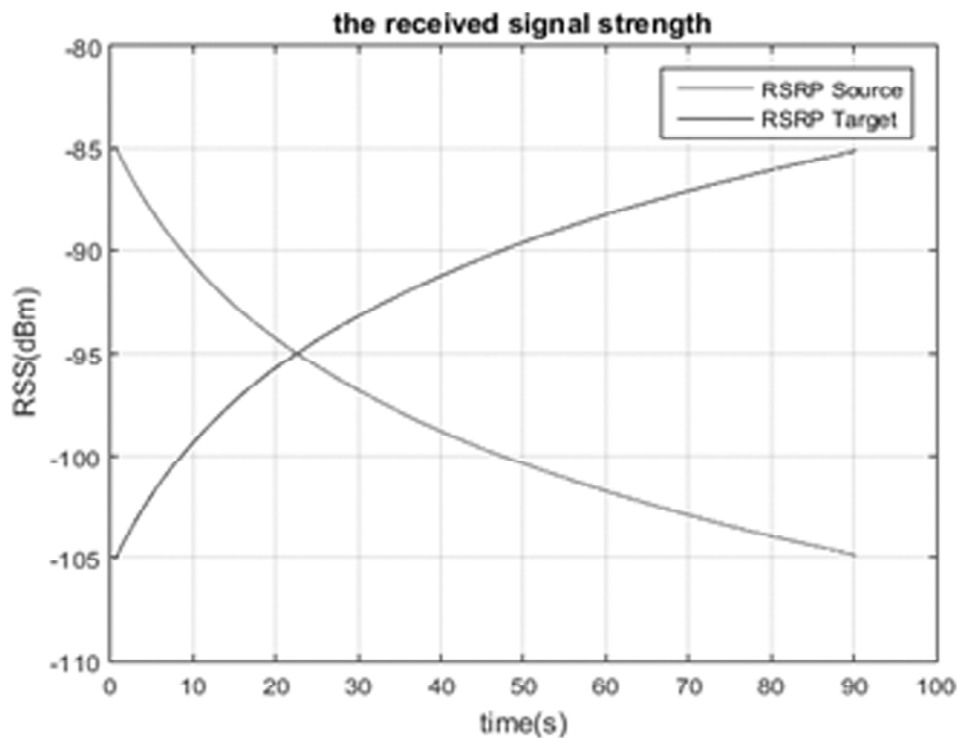


Figure 1: Received signal strength graph

#### 5. CONCLUSION AND FUTURE SCOPE

In the existing LTE scenario HHO is used to maintain the network load, HHO offers less complexities as compare to SHO, because SHO models utilizes more resources(enodeB) because it always maintain a link between the target enodeB. The results show that the proposed method is better in terms of reducing the delay so as to help in effective allocation of the resources.

The future work in this field is to develop a proper environment to implement the technique and check its efficacy in real implementation which considers the behavior of the hardware.

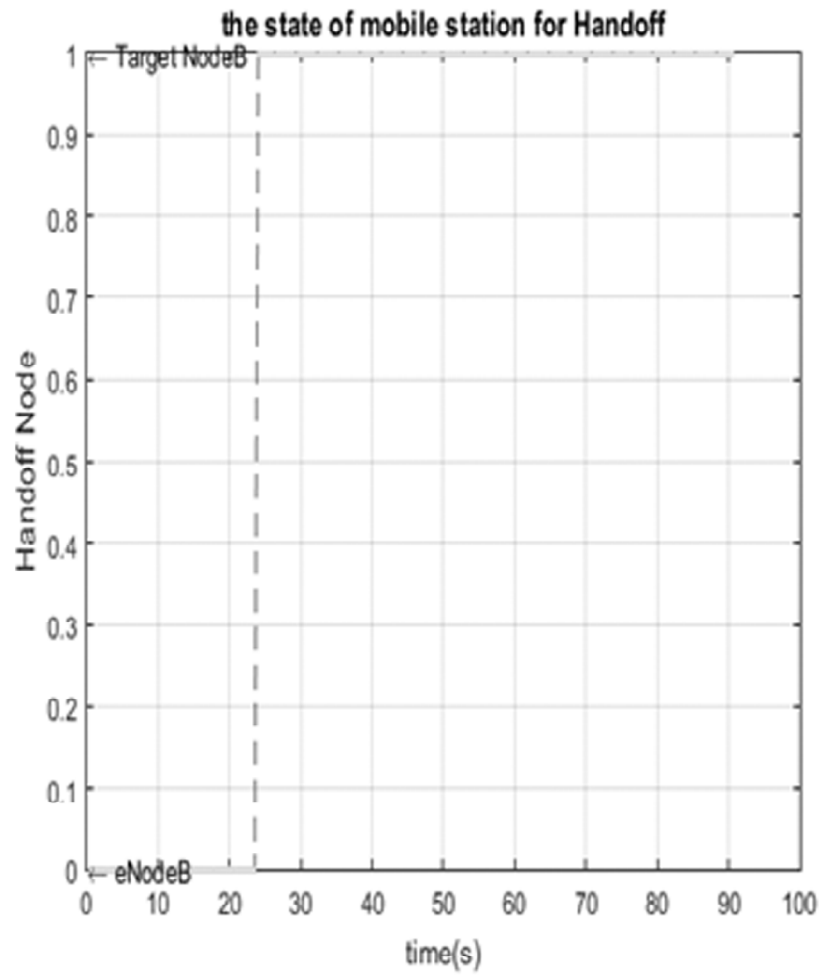


Figure 2: Mobile handoff action versus time graph

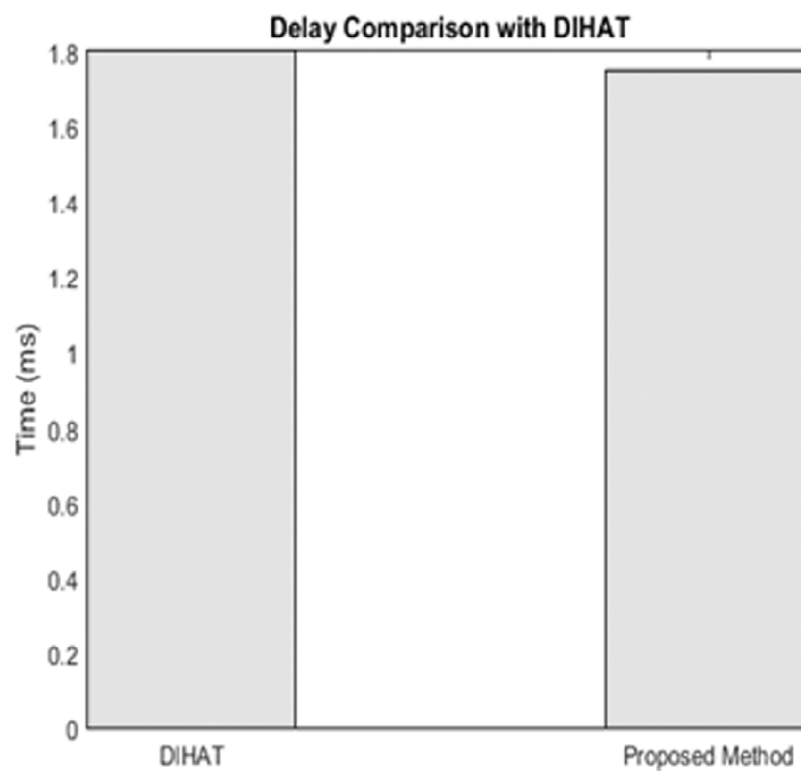


Figure 3: Delay in handoff comparison

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