ISSN 2229-5518

Enhanced Approach for RSRP Based Handover in LTE Scenario

Aparna L, Agoma Martin

Abstract— Hard handover decided by handover margin (HOM) and time to trigger (TTT) has been adopted in third Generation Partnership Project (3GPP) LTE with the purpose of reducing the complexity of network architecture. In the traditional handover scheme, the difference in the reference signal received power (RSRP) of host node and target node is obtained, which is then compared with the trigger threshold. To enhance this handover scheme two notions of handover management are considered: late handover for avoiding ping-pong effect and early handover for handling real-time services. Late handover is supported by disallowing handover before the TTT window expires, while early handover is supported even before the window expires if the rate change in signal power is very large.

Index Terms— Handover, Long Term Evolution(LTE), Handover Margin(HOM), Time to Trigger(TTT), Reference signal Received Power(RSRP).

1 Introduction

LTE is the radio access technology proposed by the third generation partnership project (3GPP) [1]. The target is to provide downlink peak rates of at least 100 Mbps, an uplink of at least 50 Mbps. It is aimed for providing excellent service for 4G networks at higher data rate and lower latency. To tackle the power saving issues of user equipment (UE), LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) as its access technology in the downlink, while Single Carrier Frequency Division Multiple Access (SC-FDMA) is used in the uplink [2],[5]. The smallest transmission unit in the downlink LTE system is known as a resource block (RB) that contains 12 sub-carriers (180 kHz total bandwidth) of 1 ms duration [3].

As illustrated in Figure 1, the LTE network consists of two main components: evolved packet core (EPC) and evolved UMTS terrestrial radio access network (E-UTRAN) [4]. EPC includes mobility management entity (MME), serving gateway (S-GW), and packet data network gateway (P-GW). The MME is a key control plane component which processes the signalling between the UE and core network, including authentication, authorization, bearer establishment, roaming, location registration management, and S-GW/P-GW selection. The protocols running in the MME are known as the non-access stratum (NAS) protocols. The S-GW performs data routing and forwarding between eNodeB and UE, which serves as a local mobility anchor for the data bearers when the UE moves between eNodeBs.

- *Aparna L, Computer science and engineering, LBS Institute of Technology for Women, Poojappura,Trivandrum, India, E-mail : aparnal854@gmail.com*
- *Agoma Martin,Computer science and engineering, LBS Institute of Technology for Women, Poojappura, Trivandrum, India, E-mail : agoma.bethel@gmail.com*

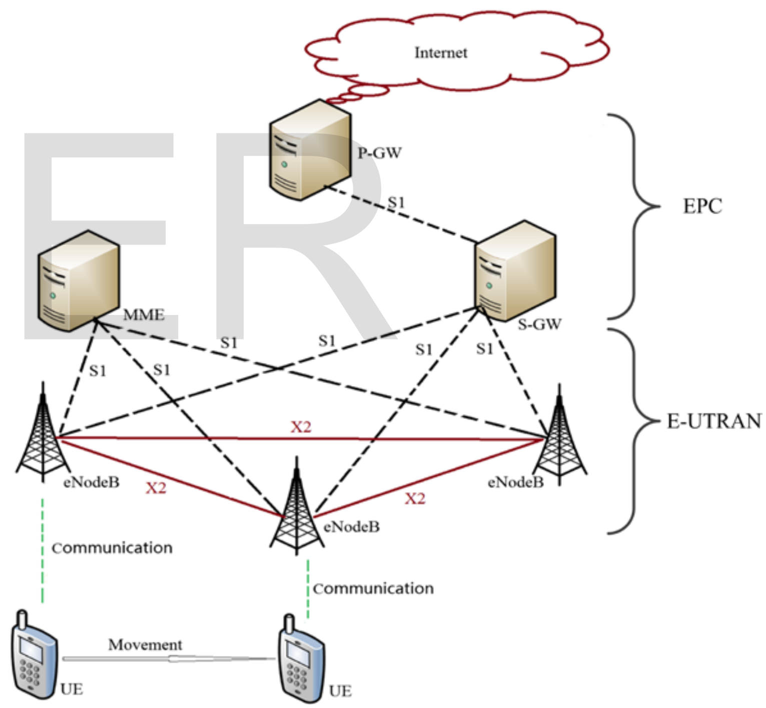


Fig 1. Structure of LTE network.

The P-GW provides the UE with the access to an external packet data network by assigning an IP address to it. The key module of E-UTRAN is eNodeB, which performs radio interface-related operations such as packet scheduling and handover. By integrating the radio controller function, eNodeB provides the air interface with the user plane and control plane protocol terminations towards the UE, minimizing the latency and improving the efficiency.

In mobile communication handover refers to the process of transferring an ongoing call or data session from the source to the target base station. A handover algorithm is a handover decision-making process which triggers handover if certain conditions specified are satisfied. An efficient handover algorithm should make handover decisions at the right time also it should avoid ping-pong handoff, that is unnecessary back and forth handoff.

2 RELATED WORK

The handover techniques of wireless communication network are classified into two types: hard handover and soft handover. Also known as *break before make* and *make-before-break*, respectively. Soft and hard handover followed by handover in LTE are discussed in the following subsections.

Hard Handover

A hard handoff is essentially a "*break before make*" connection. Here the link to the prior base station is terminated before or as the user is transferred to the new cell's base station. This means that the mobile is linked to no more than one base station at a given time. A hard handoff occurs when users experience an interruption during the handover process caused by frequency shifting. The UE communicates with only one eNodeB at any moment in time, making the network resource efficiently used. However if the handover fails, however, the communication may come across abnormal termination since the re-establishment procedure to the serving eNodeB may not always be successful or a temporary disruption is caused even when it is successful.

Soft Handover

Soft handoff is also called as Mobile Directed Handoff as they are directed by the mobile telephones. Soft handoff is the ability to select between the instantaneous received signals from different base stations. In this the connection to the target is established before the connection to the source is broken, hence this is called *"make-before-break"*. The main advantage of soft handover is lowered probability of abnormal termination due to handover failure. But while implementing this the network architecture becomes more complex.

Handover in LTE

There are two types of handover procedure in downlink LTE for UEs in active mode (Active mode means the UE is transmitting/receiving packets to/from the core network, either voice packet, or data packet.) which are the S1 and X2 handover procedures. The X2-handover procedure is normally used for the inter-eNodeB handover to balance network load and prevent interference [8]. However, when there is no X2 interface between two eNodeBs, or if the source eNodeB has been configured to perform handover towards a particular target eNodeB via the S1 interface, then an S1-handover procedure will be triggered [9]. The S1-based handover procedure is used for communicating with non-3GPP specific access technologies such as CDMA2000/HRPD. There are three phases involved in both S1 and X2 handover procedures which are preparation phase, execution phase, and completion phase [10],[11]. In the preparation phase, the UE needs to send measurement reports periodically to the source eNodeB [16]. Based on these reports, the source eNodeB will decide to which target eNodeB the UE should be handed over. Besides the measurement reports, other criteria are also considered by the source eNodeB before a control message is sent to the target eNodeB to prepare for the handover. Upon receiving the control message requesting to prepare for handover, the target eNodeB will prepare a buffer for the UE.

Once the preparation phase is completed, a handover command control message is sent by the source eNodeB to the UE in the execution phase to notify the UE that it is going to be handed over to another eNodeB. Upon receiving the message, the UE will disconnect itself from the source eNodeB and request for connection with the target eNodeB. At the same time, the source eNodeB forwards all packets of the UE to the target eNodeB. These packets are queued by the target eNodeB in the UE buffer. Once the UE has successfully connected to the target eNodeB, the target eNodeB transmits all the buffered packets of the UE followed by the incoming packets from the target gateway. The handover procedure moves to the completion phase after the UE sends to the target eNodeB a handover complete message that indicates this handover is completed.

The main purposes of the completion phase are to release all the resources used by the UE at the source eNodeB and to notify the upper layer to switch the path of the packet to the target eNodeB. Therefore, the target eNodeB needs to inform the source eNodeB to release all resources from the UE and the target MME to execute path switching to the target eNodeB, respectively.

Traditional Handover scheme

The standard hard handover algorithm is the default one used in the LTE system, which makes the handover decision based on two variables: handover margin (HOM) and TTT [12]. HOM is a constant variable representing the threshold of the difference in the received signal strengths, RSRP in dB, between the serving eNodeB and target eNodeB. HOM identifies the most appropriate target eNodeB the UE should be handed over to. Assume that a UE moves to the boundary of two eNodeBs. If HOM is adopted as an only measure for deciding the handover, then handover will continuously occur between the two nodes. This is called 'ping-pong effect', and it significantly wastes signaling resources, decreases the system throughput, and increases the packet loss and pack delay. A TTT timer is thus used for reducing unnecessary handovers. The TTT timer is started when the RSRP of target eNodeB becomes larger than that of the serving eNodeB. When a UE moves away from the coverage of the serving eNodeB, the RSRP the UE receives from the current serving eNodeB decreases as time goes on. Meanwhile, the RSRP the UE receives from the target eNodeB will increase when the UE moves towards the target eNodeB. In this case, the UE should be transferred to the target eNodeB in order to avoid call termination when the UE stays outside the range of the serving eNodeB. A handover is triggered when the following equation is satisfied during the entire TTT window.

$$RSRP_T > RSRP_S + \text{HOM}$$

Where $RSRP_T$ and $RSRP_S$ are the RSRP of the target eNodeB and serving eNodeB respectively. A handover is triggered after the TTT window expires during which the RSRP of target node is larger than that of the serving node at least as much as HOM.

3 ENHANCEMENT PROPOSAL

In the proposed scheme the handover decision is made when the difference in the RSRPs of serving cell and neighbouring cell exceeds the threshold value during the entire TTT window to avoid ping-pong effect. Also if the rate of increase of the difference in RSRP values is higher than the rate of threshold even before the TTT window expires, the handover needs to be triggered immediately to support real-time services.
The factors propose in the enhanced algorithm are:
The difference between target and serving cells are obtained and layer-3 filtering is applied to these measurements,

$$\text{RDIF}(t) = RSRP_T(t) - RSRP_S(t)$$

$$\text{FRDIF}(t) = (1-\alpha)\text{FRDIF}(t-1) + \alpha\text{RDIF}(t)$$

Here, FRDIF(t) and FRDIF(t −1) are the filtered values of RDIF(t) and RDIF(t −1), respectively. The values are controlled by the averaging factor α. Note α is smaller than 1. Here α is set to 0.5. The initial values of FRDIF(t) can be defined either by averaging several RDIF(t) values of the previous periods or the first value of RDIF(t)[13]. In the proposed algorithm, it is set to zero.

The handover is triggered when the TTT window is over while the following condition is satisfied during the entire TTT window.

$$\text{FRDIF}(t) > \text{HOM}$$

Handover is also triggered even before the TTT window is over if the following condition is satisfied,

$$\text{FRDIF}(t) = \text{HOM} + \alpha\text{HOM}$$

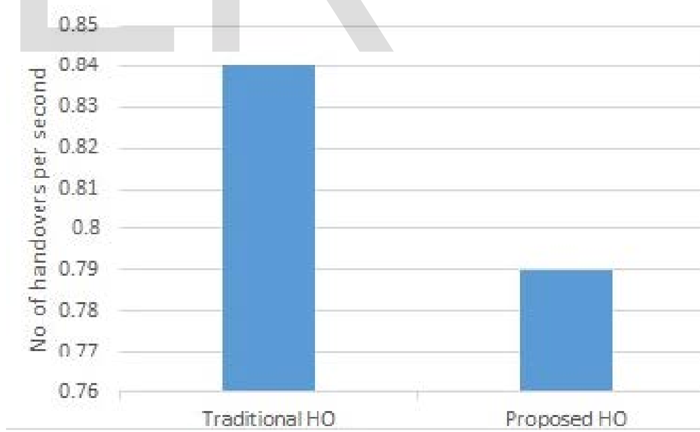
That is two different scenarios are considered for triggering handover. These scenarios support late handover for avoiding ping-pong effect and early handover for handling real-time services. Late handover is supported by disallowing handover before the TTT window expires, while early handover is supported even before the window expires if the rate change in signal power is very large.

5 EXPERIMENT RESULTS

The proposed method is implemented in network simulator NS3.
The scenario is with five cells with the radius of 500 m is used as the target network of the simulation. The parameters HOM and TTT used for the proposed scheme are 3 dB and 256 ms.
The eNB Tx power is set as 46 dBm. The UE speed is considered to be 20 m/s and mobility model is set as constant velocity mobility model. The run time is set as 75 s.
The performance metric considered here is Average number of handovers per second.

$$\text{Number of HO} = N/T$$

where N is the total number of handovers and T is the simulation time.
And comparing with the existing system, the resulting graph is as shown below :



6 CONCLUSION

Handover is an important operation in wireless network, especially for real-time services in mobile environment. Minimizing unnecessary handover is of great importance in this environment.
It is shown in the simulation results that the proposed handover algorithm can effectively minimize the unnecessary number of handovers compared with the traditional algorithm.

ISSN 2229-5518

Acknowledgment

We are greatly thankful to our principal,Dr. JAYAMOHAN J, Dr. V GOPAKUMAR, Head of the Department of Computer Science and Engineering, Mr. MANOJ KUMAR G, Associate Professor, Department of Computer Science and Engineering, for their support in the successful completion of this paper.

REFERENCES

[1] 3GPP Scope http://www.3gpp.org

[2] J Zyren, W McCoy, Overview of the 3GPP Long Term Evolution Physical Layer ((Freescale Semiconductor, Inc, 2007). white paper). http://www.freescale.com/files/wireless_comm/doc/white_paper/3GPPEVOLUTIONWP.pdf.

[3] H. Holma and A. Toskala, LTE for UMTS: OFDMA and SC-FDMA Based Radio Access, 1 ed.: John Wiley & Sons Ltd., 2009.

[4] HG Myung, Technical Overview of 3GPP LTE (Polytechnic University of New York, 2008) http://tech-books-pdf.googlecode.com/git/LTE/3gppLTE.pdf.

[5] 3GPP, Tech. Specif. Group Radio Access Network; Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN) (3GPP TR 25.913 V9.0.0), 2009

[6] J Huang, F Qian, A Gerber, ZM Mao, S Sen, O Spatscheck, A close examination of performance and power characteristics of 4G LTE networks, in Proceedings of IEEE 10th International Conference on Mobile Systems, Applications, and Services, 2012, pp. 225–238

[7] 3GPP, Tech. Specif. Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 V10.0.0), 2010

[8] A Nagate, S Nabatame, D Ogata, K Hoshino, T Fujii, Field experiment of CoMP joint transmission over X2 interface for LTE-Advanced, in Proceeding of IEEE 77th Vehicular Technology Conference (VTC Spring 2013), 2013, pp. 1–5

[9] E. Dahlman, S. Parkvall, J. Sköld, and P. Beming, 3G Evolution: HSPA and LTE for Mobile Broadband, 2007.

[10] 3GPP, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (EUTRAN)access (Release 8) TS 23.401 V8.7.0," 09-2009.

[11] 3GPP, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (EUTRAN); Overall description; Stage 2 (Release 8) TS 36.300," 05-2008.

[12] K Dimou, M Wang, Y Yang, M Kazmi, A Larmo, J Pettersson, W Muller, Y Timner, Handover within 3GPP LTE: design principles and performance, inProceedings of IEEE 70th Vehicular Technology Conference (VTC 2009-Fall),2009, pp. 1–5

[13] Ericsson, Proposed Reference Assumption for RSRP measurement Accuracy, 3GPP TSG-RAN WG4 Meeting #43 R4-070593 (Kobe, Japan, 2007)