IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-5, May 2018 E-ISSN: 2347-2693

A study of X2 and S1 Handover in LTE Networks using MATLAB

B. Singh[1*], M. Yadav[2]

[1]Department of Computer Science, Guru Jambheshwar University Of Science and Technology, Hisar, India
[2]Department of Computer Science, Guru Jambheshwar University Of Science and Technology, Hisar, India

[*]*Corresponding Author: bn2mehlan510@gmail.com, Tel.: +91-94166-69174*

Available online at: www.ijcseonline.org

Accepted: 22/May/2018, Published: 31/May/2018

***Abstract*—** A load balancing method is proposed for the long term evolution networks. Today the traffic on networks is growing because of huge requirement of higher data rates for e.g. for Video streaming, Video conferencing, Online gaming etc. This demand results in excess load on the networks due to which the networks suffer from the heavy load and the quality of networks get degraded. The Load balancing is achieved between the loaded cell and its neighbor cells which are directly connected to each other and one of them have enough available resources so that the load can be shared with the neighbor node. In this work, we have proposed a method for load balancing in LTE networks which shows the simulation of two scenarios in which the handover is done between the LTE to LTE and LTE to Non LTE network nodes done.

***Keywords*—**LTE Networks, Mobility, Handover, Load Balancing

I. INTRODUCTION

Today increase in digital data processing devices through the internet paved the way for the requirement of higher data rates with the quality of services. 3gpp (Third Generation Partnership Project) designed complete new network LTE (Long Term Evolution) in order to curtail the network complexity furthermore improve the performance of the network. User equipment and the base station is collectively named as EUTRAN which is Evolved Universal Terrestrial Radio Access Network and EPC which is Evolved Packet Core that comprises of MME, HSS, SGW /PGW etc [1]. 3ggp has simplified the frequency spectrum, resulting in higher data rates.) In case of downlink LTE networks uses OFDMA that is Orthogonal Frequency Division Multiple Access and in case of uplink SC-FDMA that is Single Carrier Frequency Division Multiple Access with scalable carriers 1.4, 3,5,10, 15, 20 Mhz. Physical frame of LTE is 10ms, Half Frame 5 ms, Sub-frame 1 ms and a slot 0.5 ms long. SON (Self Organized Networks) feature introduced later in LTE releases. SON consists of self-configuration, self-healing and self-optimization that minimized the cost and up gradation time [2] [3] [4] [5].

UE is the user equipment which communicates to the server or others UE's via long term evolution network. eNB's are the serving cells which provide access to the network via the radio interface. Previously, these were known as base stations in GSM/CDMA networks. In case of Long Term Evolution networks, 3gpp has tried to impose most of the functionality on the eNB's. eNB's in a network are linked to each other using X2 interface and also connected with MME,SGW/PGW etc using S1 interface. UE's interacts with MME, SGW /PGW, and Internet via eNB's. eNB's controls mobile devices by sending and receiving signal messages. HSS (Home Subscriber Server) stores the information of mobile users. SGW acts as a router between the PGW's and eNB's.PGW performs packet filtering, IP allocation and also connects the network to the internet. LTE uses both FDD (Frequency Division Duplex) and TDD (Time Division Duplex) as its duplexing parameter. QPSK, 16QAM, 64QAM are the modulation schemes used by the LTE network for modulation and demodulation on the network. MIMO is being used by LTE, is an antenna technology for wireless communications in which various antennas are used at both the transmitter and the receiver. The antennas at each end of the communications circuit are combined to reduce errors and optimize data speed [6].

Long term evolution networks are designed as flat IP based and fully packet switched networks in order to achieve faster data rates and simplify the network architecture. LTE network is the combination of E-UTRAN abbreviation for Evolved Universal Terrestrial Radio Access Network and EPC is Evolved Packet Core. E-UTRAN acts as the radio interface for the network. It contains radio access management, user, and control plane for the user devices. E-UTRAN has two main entities UE and eNodes. UE is the User Equipment or user device. It can be any smartphone. Tablet or any other smart device connected to LTE network.

The core part of LTE network is EPC. Evolved Packet Core contains MME, S-GW, P-GW, and HSS as main entities. MME is Mobility management entity which provides user authentication like services and is the leading entity for EPC.

S-GW (Serving Gateway) acts as the data communication entity or data communication point in the LTE network. P-GW (Packet Gateway) assigns IP addresses to the user equipment and P-GW performs handover between LTE and Non LTE networks. HSS (Home Subscriber Server) is the core database. It contains the user details, profiles which are used in user authentication process and tracking of services.

As a last paragraph of the introduction should provide organization of the paper/article (Rest of the paper is organized as follows, Section I contains the introduction of LTE Networks , Section II contain the related work related to the Load Balancing Techniques in LTE Networks, Section III contain the methodology obtained to carry out handover in LTE networks, Section IV contain the details about the results and discussion of load balancing method simulation in LTE Networks, section V explain the conclusion and Future scope of the work.

II. RELATED WORK

There are mainly three types of interface in the LTE network. LTE-UE is the interface between user devices and the eNodes in the LTE network. X2 Interface is used to connect different eNodes to each other in the LTE Network. S1 interface is used to connect LTE nodes to Non LTE nodes. It is also used to connect eNodes to MME entity also. By the handover process, one device connected to one network cell is transferred to another network cell which one is better than the current network cell. Hence the handover is process is an important part of mobile networks.

It helps to provide mobility to the users without disconnecting their call or communication or any kind of data loss. Hard handover and Soft handover are the types of handover based on the programming nature. Handover is carried out between LTE to LTE cells via X2 handover and LTE to Non LTE cells via S1 interface. Handover procedure is carried out in three steps; these are handover initialization, handover execution, and handover completion. In the first phase of handover, the UE transmits its measurements reports to its source node. After receiving the reports the serving node checks if there is need of handover or not. If so then it finds out the better neighbor node to handover the device to that. Once if a source or serving node decides that handover is required it generates handover request and sends handover call message to the target node. In case the target node accepts the handover request it allocates the required resource blocks to the requesting UE or user device and provides handover acknowledgment feedback to the current source node. It contains RRC_Connection_Reconfiguration massage. In the second phase, the serving node sends the RRC_Configuration massage to the UE. The current node transmits the data packets to the target node using X2 interface or S1 interface. After receiving the RRC_Configuration massage UE releases its currently held resources of the source node and starts data synchronizing with the target node. UE sends RRC_Configuration_Complete massage to the target node in order to authenticate the handover process completion. In the last phase, the target node receives RRC_Configuration_Complete massage from coming UE. The target node requests the Mobility Management Entity (MME) to change or modify the data path of UE. Then the MME tells S-GW regarding the path modification of the UE.

III. METHEDOLOGY

The basic aim is to reduce the load of a network cell in order to increase its utilization and performance improvement. Initially a LTE network is created and the network parameters are initialized. These parameters will be used by both the network cells and the mobile devices in order to perform data commutation and to reduce load handover procedure as well.

After the initialization the network cells and the device is deployed in the network. Next step is to connect or establish a link from device to one of the network cell. And the connected will be acting as source cell or serving cell. Network manager function is executed. Its work is to identify the source cell for the device and establish data communication via these network cells. The network cells manages links to devices based on various parameters like RSS (Received Signal Strength), Network cost, bandwidth consumed, hysterias, TTL (time to live) values etc.

In this process the communication between the devices and source or serving cell starts and the device starts moving as well with a certain speed. As the device moves in the network, the network cells keep tracks of the device based on the measurement reports by the device. When the RSS values gets lower and the network cost gets higher during the network live a handover request is generated by the serving cell to the target cell. If the target cell accepts it handover process is triggered. If there is a successful handover than device is attached to target cell otherwise device may get back to source cell or may disconnect.

In Long Term Evolution networks the serving node takes care of handover decision for the UE (User Equipment). UE helps the serving node in this decision for by sending them measurement reports. The measurement report contains various values or parameters like RSS (Received Signal Strength), Bandwidth or Resource allocation details, Network Cost, Hysteresis, TTL etc.

RSRP is the average power required from the network resources is Reference Signal Received Power. It is

measured from the serving node transmitted power (Tx), the path loss values from UE to Serving node and shadow fading.
RSRP = Tx-Lue-Lfad.
And the RSRQ (Reference Signal Received Quality) is calculated as
RSRQ=n*(RSRP/RSSI)
Here the n denotes the how many Resource Blocks are and RSSI denotes the Received Signal Strength Indicator.

IV. RESULTS AND DISCUSSION

We simulate X2 handover and S1 handover in this work using MATLAB as a simulation tool. In this simulation we have assumed two scenarios, in first scenario both the node in the LTE network are LTE nodes and in the second scenario One node is LTE node and the other node is Non LTE node. The device or UE is moving at the speed of 5m/s. The moving device calculates RSRP and RSRQ values and transmits them back to the source node or serving eNode.

Depending upon the measurement reports, the source cell sends handover request to its neighbor cell if the reports meet the required condition for the handover. If the neighbor cell is better for the User Device and the neighbor cell accepts the handover request then the handover process is initiated. Still, the UE continues to measure the environment. Source cell transition power is taken as 45 and the device speed is 5m/s. for the simulation purpose [7][8][9][10][11][12][13].

For the proposed algorithm we have assumed a network in 2-D (Dimensional) space of 600*600m. In which first cell is co-ordinates at [0, 0] , second cell co-ordinates at [600,0] and the device coordinates at [100,0]. The following are the parameters used in implementation as shown in Table 1:-

Table 1. Simulation Parameters

Parameter	***Value***
Network size	600*600m
Number of UE's	1
UE Speed	0.5m/s
Number of eNode's	2
Frequency	2000,1800Mhz
Time Quantum	0.5
Tx Power	45dBm
Fading Values	Random

A. Results

- RSSI: - The effects of change of source node transmitted, power during the movement of the device is simulated. We have used the simulation parameters as shown fig1 and fig2. Time is taken 0 to 200 seconds. Approximately at 35 seconds in network1 and at approx 70 seconds in network2 the RSSI for the neighbour cell becomes better as compared to the serving cell. Thus the handover takes place and the device is moved to the target cell or neighbour cell because of better signal strength. But near about 100 second in both the networks second cell loses its signal strength due to the moving nature of the device, the device connects back to the previous serving cell or cell1 because there is some signal available of cell1. But after some time whenever the cell2 signal comes the device gets back to the cell2. At last, when there is no signal available from any of the cell, the devices get disconnected from the LTE network due to the no signal availability.
- Bandwidth: - Bandwidth is the capacity of the network. It defines the baud rate or data rate at which network will transfer or receive data. As the networks evolved the bandwidth also has become higher. The LTE networks use higher frequencies as compared to other networks. More the bandwidth more the network resources. The fig 3 and fig 4 shows the frequency band of network1 and network2.
- Handover: - As we have seen in the previous analysis the device is moving to cell2 due to the handover process. As we can see the handover transitions in the fig 5 and fig 6, in case of network1 at time 45s, 90s, 105s (approx) and in network2 80s, 90s, 120s, 130s and 180s (approx) the handovers are done.
- Network Cost: - Network cost is a parameter which is taken into consideration during handover process. It helps in taking the handover decisions. Network cost depends on various factors like operational cost, network resources utilization cost and many more. In this work, we have assumed some fix values for the network cells. Fig 7 and fig 8 shows the network cost.)

B. Figures

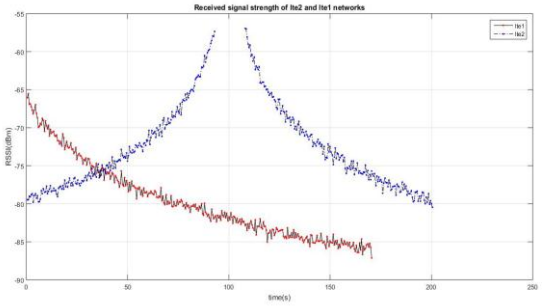

Figure 1. RSSI of LTE1 and LTE2 Cell

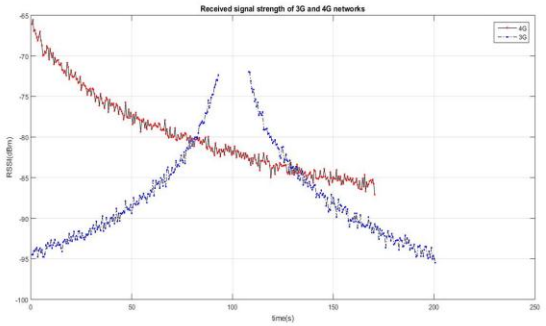

Figure 2. RSSI of LTE and 3G Cell

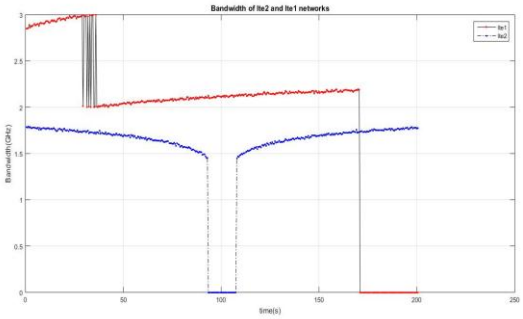

Figure 3. The bandwidth of LTE1 and LTE2 Cell

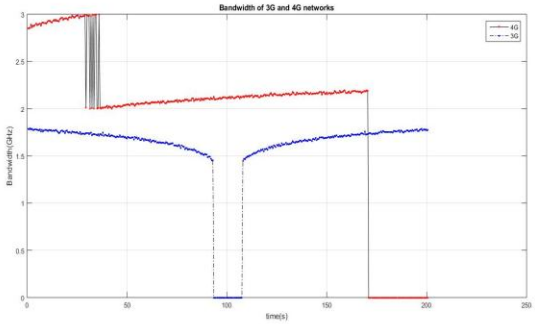

Figure 4. Bandwidth of LTE and 3G Cell

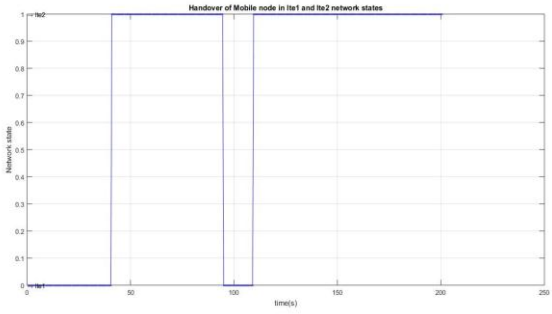

Figure 5. Hanover between LTE1 and LTE2 Cell

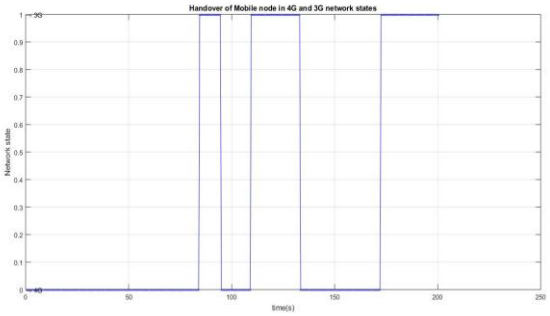

Figure 6. Handover between LTE and 3G Cell

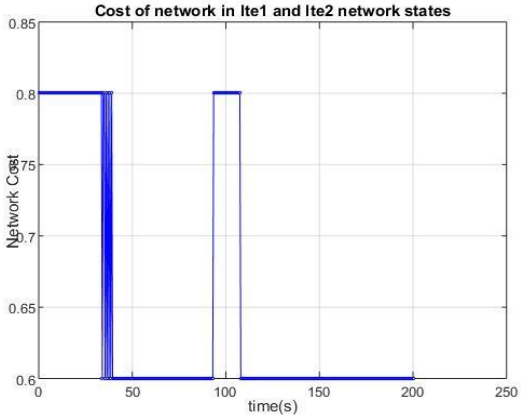

Figure 7. Cost of network LTE1 and LTE2 Cell

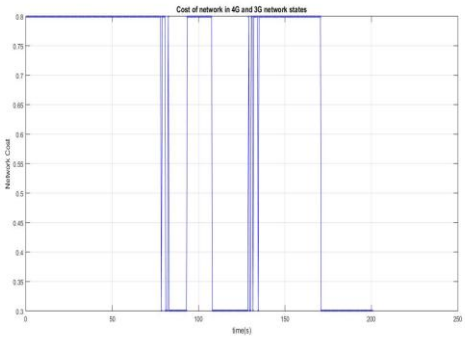

Figure 8. Cost of network LTE and 3G Cell

V. CONCLUSION AND FUTURE SCOPE

In this paper, we simulate the proposed method through MATLAB for handover in long term evolution networks using A3 Event. We evaluated the performance of the algorithm in Load balancing context. The analysis is made on the basis of RSSI indicator, handover, network cost and bandwidth in the network. The results show the simulation of two networks in which LTE to LTE handover via X2 interface and LTE to Non LTE cell via S1 interface. Our main contribution in this paper is the implementation of Load Balancing algorithm using MATLAB. It is concluded from

the results obtained that this algorithm performs handover between long term evolution networks and also between long term evolution networks and other types of mobile networks. Quality of long term networks is improved because various parameters are taken into consideration.

In future, this method can be further enhanced to increase better utilization of the network resources. As the quality of the LTE networks is improved thus thesewill become more useful and cost-effective in future.

REFERENCES.

[1] R. Divya and A. Huseyin, *"3GPP – Long Term Evolution – A technical Study,"* Spring 2009'.

[2] A Technical White paper,*"Long Term Evolution (LTE): A Technical Overview"*, Motorola

[3] D. Astely, E. Dahlman, A. Furuskar, Y. Jading, M. Lindstrom, and S.Parkvall, *"LTE: The Evolution of Mobile Broadband"*, LTE PART11: 3GPP Release, Ericsson Research.

[4] M. Meyer et al., *"ARQ Concept for the UMTS Long-Term Evolution,"* VTC Fall 2006, Montreal, Canada, Sept. 2006.

[5] Alatishe S. Adeyemi 1 , Dike U. Ike 2, *"A Review of Load Balancing Techniques in 3GPP LTE System"* , ISSN : 2319-7323, Vol. 2 No.04 July 2013.

[6] Tutorialspoint, online [Available] : *https://www.tutorialspoint.com/lte/*

[7] 3GPP. TS 36.214, Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Layer; Measurements. V11.1.0, February 2013.

[8] 3GPP. TS 36.331, Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol Specification. 11.8.0, July 2014

[9] L. Luan, M. Wu, X. He and J. Shen, *"Optimization of handover Algorithms in LTE High Speed Railway networks",* International Journal of Digital Content Technology and its Applications (JDTCA), 2012.

[10] H. Song, L. Yan and X. Fang, *" Handover Scheme for 5G C/U Plane Split Heterogeneous Network in High Speed Railway"*, IEEE Transaction on Vehicular Technology, Vol. 63, No 9, pp. 4633-4646, November 2014.

[11] E. Tuncel, *"Tuning of handover parameters in LTE-A heterogeneous networks",* Master Thesis, 2014.

[12] Y. Zhang, L. Luan, S. Ge and M.wu, *"Optimization of time-to-trigger parameter on handover performance in LTE high speed railway networks"*, 15th International Symposium on Wireless Personal Multi Media Communications (WPMC), pp. 251-255, 2012.

[13] M. Assuyadly, A. Silitonga and A. Suhartomo, *"Evaluation of X2-Handover Performance Based on RSRP Measurement with Friis Path Loss using Network Simulator version 3 (NS-3)",* 2nd International Conference on information and communication technology, pp. 436-441, 2014.

Authors Profile

Mr. Balwant Singh received Diploma in Computer Engineering from Government Polytechnic Jhajjar , Haryana in 2010; Bachelor of Technology in Computer Science and Engineering from Shanti Niketan College of Engineering, Hissar, Haryana in 2014 and currently attending Master of Technology in Computer Science and Engineering in Guru Jambheshwar University of Science and Technology , Hissar, Haryana since 2015. He has published more than 3 research papers in reputed international journals and national journals. His main research work focuses on load balancing Algorithms, Long Term Evolution (LTE) Networks.

Mr Manoj Yadav is currently working as Assistant Professor in the department of computer science & Engineering of Guru Jambheshwar University of Science & Technology, Hisar, Haryana. He is currently pursuing PhD. He has published more than 10 research papers in reputed international journals and conferences.His main research work focuses on computer networks and Mobile Computing. He has more than 5 years of teaching experience.

