Handoff Between LTE-LTE Networks using Qual Net Simulator

S. Neeraja, A. Abhishiktha

Abstract*: *The vast expansion of technology in the field of wireless networks, upcoming users can acquire maximum data even under mobility. To experience such type of environment, users need to stay in a network with highly improved technologies under seamless mobility with better handoff. By considering this, handoff between the homogeneous wireless networks is introduced. In order to make a handoff between the mobile nodes flag mobility concept is used between the homogeneous networks. In this paper, a scenario is designed for homogeneous handoff between 4G- LTE (Long Term Evolution) networks with flag mobility using QualNet 8.0 network simulator. The handoff performance is estimated by analyzing QoS (Quality of Service) parameters such as throughput, jitter and average end to end delay.

Index Terms*: *Handoff, Homogeneous Network, LTE, QualNet 8.0.

I. INTRODUCTION

High speed Internet with mobility is required for doubling the demand of Integrated wireless networks. When the mobile node is changing its position from one location to other an uninterrupted connection is maintained by means of handoff [1] [2]. Handoff is the process of assignment of a current call from one channel to the other channel of core network or it is the assignment of call between two base stations [3]. Handoff between the similar networks with same technology, then it is called as horizontal handoff or homogeneous handoff. In order to make the continues connection with handoff requires the fulfilment of mobility and session management among the networks [4]. An efficient distributive and mobility management [5] system can be helpful in different applications those are secured data base entry monitoring, focusing on QoS, parallel arrangement of data in mobile wireless applications, digital media files.

This paper presents implementation of the homogeneous handoff between the two wireless LTE networks using QualNet simulator. LTE is originated from a Universal Mobile Telecommunication System (UMTS), which is originated from the Global System for Mobile Communications (GSM). Massive usage of mobile data due to development of many new apps for gaming, streaming, browsing and IPTV have triggered the researchers to work on the LTE.

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The network architecture of LTE is planned to design in such a way that it provides higher data rate with packet-switching with smooth mobility. In present days, researchers are having a big task to integrate various technologies. Smooth mobility among these networks will give us the best QoS to end users. In this paper section 2 describes the LTE protocol architecture, section 3 explains the handoff performance parameters of LTE network, section 4 describes the handoff between the LTE-LTE networks, section 5 explains the simulated end result & section 6 ends up with the result analysis.

II. LTE PROTOCOL ARCHITECTURE

LTE is derived from the Universal Mobile Telecommunication System(UMTS). It is promoted by the third generation partnership project (3GPP). It is an upgrade version of both GSM and UMTS. The main motivation to design the fourth generation mobile LTE is increasing in the demand towards mobile TV, online gaming and voice over IP. The main features of LTE are:

i) Voice over LTE: It is used for the high speed voice and data services in wireless communications for mobile phones.
ii) Circuit switched fallback: Using LTE networks data services are provided if user wants a voice call then it is fall back to the circuit switched domain.
iii) Concurrent voice and LTE: The receiver works as LTE and circuit switched mode at the same time, where LTE is used for the data communication and circuit switched mode used for the voice services.
iv) Single radio voice call continuity: It can perform the voice call using customer's private internet connection with the help of mobile handset.
v) Enhanced voice quality: It can support the full HD voice by using codec that support the frequency up to 16 kHz. Previously the codec for the cell phones supports the 3 kHz only.

LTE can support the high data rates with downlink by 300Mbps and uplink 75 Mbps in a carrier of 20MHz. It can also support the high QoS, low latency and the design of the LTE support the packet switching.

In LTE all the interfaces between nodes are IP based and Base stations in 2G & 3G networks is now termed as eNode B (Enhanced Node B) in LTE. The LTE protocol architecture consists of two planes (i) User plane (ii) Control plane. In user plane data packets are generated which is planned 3 by User Datagram Protocol (UDP), Internet Protocol

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(IP) and Transmission Control Protocol (TCP). The control plane composes the information that is transferred between mobile and base station. In above two cases before reached to the physical layer the data is arranged by Medium Access Control (MAC) protocol, Radio Link Control (RLC) protocol and Packet Data Convergence Protocol (PDCP).

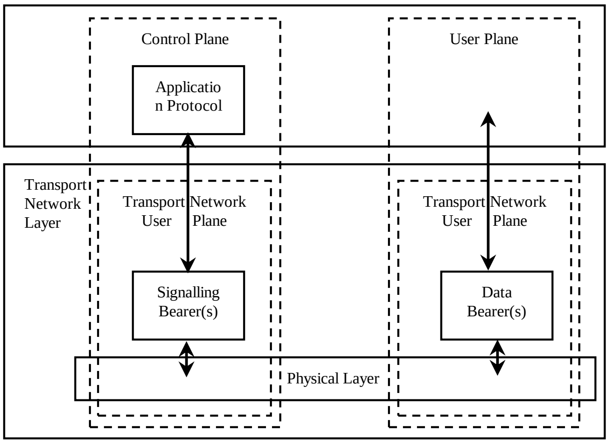

Fig.1. *Protocol architecture of LTE*

A. Control Plane

Control plane introduces RRC (Radio Resource Control layer) for lower layer configurations. Radio specific process will be handled by the control plane based on the user equipment state. User equipment have two states one is idle state and another one is connected state.

In idle state the mobile unit stays in identified cell else in re identification approach in which radio link quality and radio access technology are considered. To identify incoming calls and to know system data. The mobile unit also monitors a paging channel. In this, cell identification or re identification procedure protocols are included in control plane.

In connected state the mobile unit provides downlink channel quality for E-UTRAN to detect best appropriate cell. Here, RLC protocol is included in control plane protocol.

LTE is best technique compared to earlier techniques. Data traffic is maintained constant with Bellman Ford protocol with Constant Bit Rate (CBR) application. Smooth mobility is achieved without any packet loss by using Flag mobility.

III. LTE HANDOFF PERFORMANCE PARAMETERS

Different parameters are considered in order to find the performance of handoff in homogeneous network using QualNet. The parameters such as throughput, jitter and end to end delay are examined.

A. Throughput

The ratio of amount of data transformed from the source to target to the time that is required to transform the data from the source to the destination. Mathematically it is represented as

$$\text{Throughput} = \frac{\text{Amount of the data reaches the destination(bits or bytes)}}{\text{Time at the destination} - \text{Time at the source(seconds)}}$$

Normally it is expressed in bits/sec or bytes/sec.

B. End –to –End delay

The time in which a data packet is transfered from source to the destination. It used to define the packet transmission time. For achieving good transmission system, the end to end delay must be low. Mathematically it is represented as

$$\text{End to End delay} = \text{Time of the first packet received at server} - \text{Time of the first packet transmitted at client}$$

C. Jitter

It shows the time deviation of the packets to reach the destination. It caused due to route selection of the packets to arrive at the destination, network traffic, and timing drift.

jitter=reception time of the first packet - Reception time of the second packet that reaches the destination

IV. HOMOGENEOUS HANDOFF BETWEEN LTE-LTE NETWORKS

Homogeneous LTE networks provide smooth mobility with horizontal handoff. A Graphical User Interphase (GUI) inbuilt in simulator is used to design a scenario. In this, QualNet Network simulator 8.0 [8] is used to imitate the mobility of mobile unit among various e Node B's of homogenous LTE networks. Before implementing the network protocol architecture at outside environment it is better to check the planning model with software and minimize some extra features based on our requirements is a cost effective approach. By using the QualNet simulator it is easy to create a scenario with different environmental conditions that user likely to work.

Qualnet can work in two configurations: 1) GUI 2) Command line interphase. In GUI configuration the scenario is created by different tools those are Architect, Analyzer, Packet Tracer, File Editor. Architect is worked under two modes one is (i) Design mode (ii) Visualization mode. In the design mode the network scenario is created by using terrain, different network configurations, mobility pattern, different weather conditions, subnets and wireless network devices. In visualization mode how the packets are moving from one layer to the another layer is observed while simulation is in progress and these analyses are in dynamic form.

Analyzer is used to provide the simulation results in static form. Once the simulation is completed the analyzer can provide the multiple set of reports to check the performance of the designed network. All these static data are also saved in row wise and column wise. Packet tracer is used to provide the information about how the packets are moving during the simulation. File editor is used to display and edit the selected file in text format.

The command line interface switches the user to operate in the DOS prompt. If the QualNet is operate in the command prompt, then the input is given in the form of text.

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GUI configuration is selected in order to create the scenario.

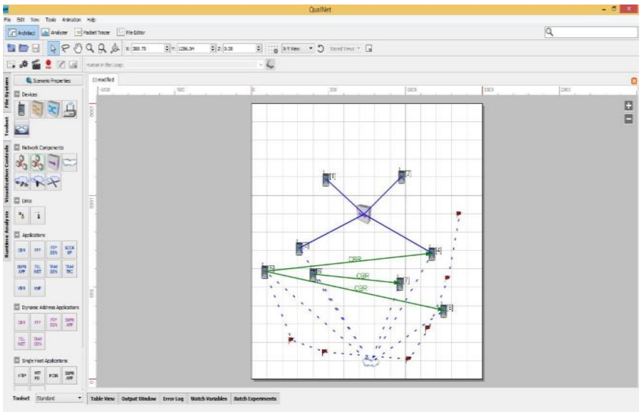

Fig. 2. *Interconnection of LTE-LTE networks*

Fig. 2 shows the interconnection of two LTE networks. In order to design LTE network, consider the HUB for connecting the Gateways, Mobility Management Entity (MME) and one System Architecture Evolved (SAE)) and e Node B. Here in this scenario Node 1 and Node 2 are MME and SAE. Node 3 and Node 4 are e Node B's. Node 5, Node 6, Node 7 and Node 8 are mobile nodes. Among these nodes apply flag mobility to one mobile node. Here the flag mobility is applied to the Node 5, initially it is connected to the e-Node 3 Apply Constant Bit Rate (CBR) from Node 5 to Node 4, Node 5 to Node 8 and Node 6 to Node 7.

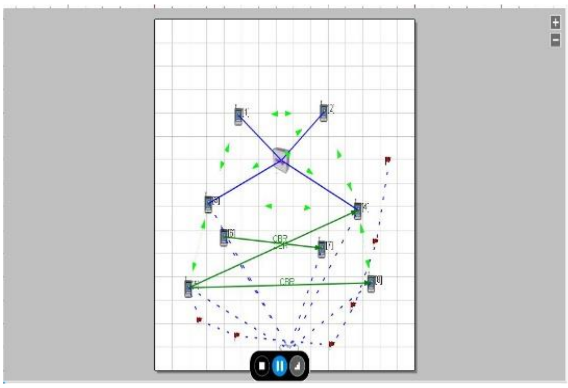

Fig. 3(a). Interconnection of LTE-LTE networks before handoff

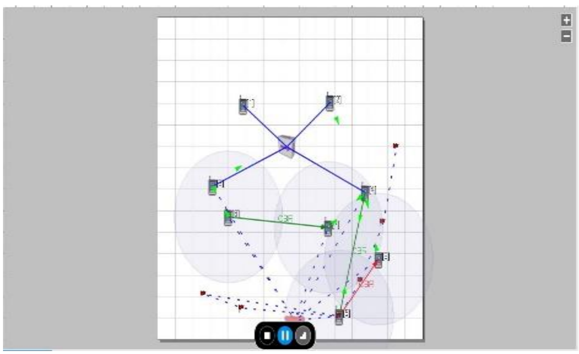

Fig. 3(b). *Interconnection of LTE-LTE networks after handoff*

Initially Node 5 is connected to the Node 3 it is observed in Fig. 3(a) when the simulation is progress the connection between Node 5 and e-Node 3 is handover to the Node 5 and e-Node 4 it is observed in Fig. 3(b) by green arrows. LTE supports smooth connection to already existing networks. LTE maintains high quality of service with guaranteed bit rate (GBR) for its users. There are several parameters that are given to the network in the QualNet given away in the below table.1.

Table 1. *Design consideration of LTE network*

Parameters	**Values**
Channel type	Wireless Channel
No of Mobile Nodes	4
Traffic Source	CBR
Routing Protocol	Bellman-Ford
Antenna	Omni directional
Time to Simulate	3000 Sec.
Frequency of Channel	2.4 GHz
End to end messages sent	1750
Item size	512bits
No of LTE channels	1

V. RESULTS

The results obtained by the simulation of horizontal handoff between two LTE networks are described in this section. The network performance is analyzed by observing various parametric values such as total no of messages received, throughput, end to end delay & jitter.

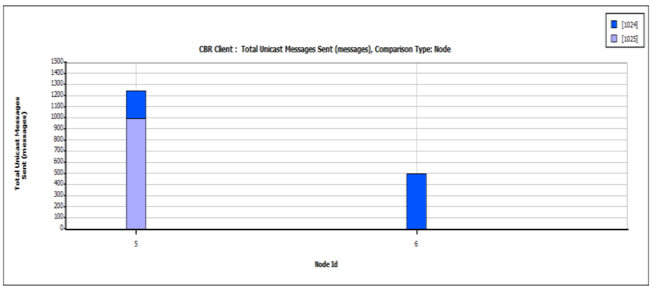

Fig. 4. *Total Unicast Message Sent vs Node Id*

Fig. 4 shows the no. of packets that transmitted from the Node 5 and Node 6. Total messages send from the Node 5 to different nodes is 1250 messages. Out of 1250 messages 1000 messages are send to the Node 8, 250 messages are send to the Node 4. From the Node 6 the messages are send to the Node 7. The messages send from the Node 6 to Node 7 are 500.

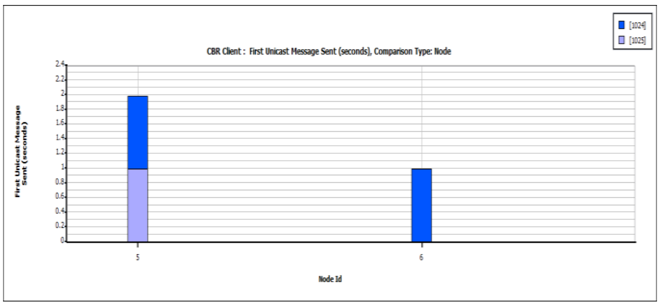

Fig .5. *Time of the first packet sent*

Fig. 5 represents the time of the first packet sent from the client to the receiver. It is noticed that the client sent the information simultaneously to the all nodes.

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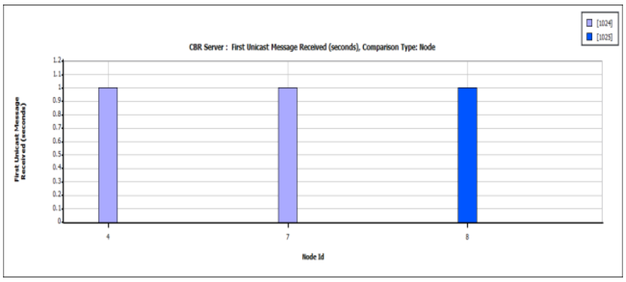

Fig .6 *Time for first packet Received*

Fig. 6 gives the information about time for first packet received at the server. It is observed from the figure that all the servers receive the first packet at same time.

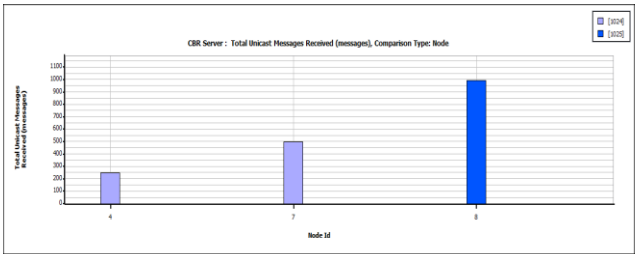

Fig .7. *Total Received Message vs Node Id*

Fig. 7 shows the total no. of packets received at Nodes 4, 8 from source Node 5 and at Node 7 from source Node 7 as messages. Messages at Node 4 are 250, number of messages received at Node are 500 and at Node 8 messages are 1000. It is observed that number of packet sent and the number of packet received are same. i.e. no data loss in the network.

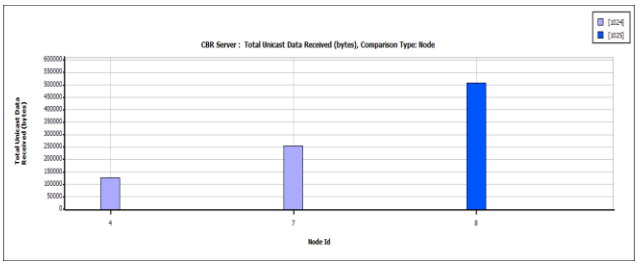

Fig .8. *Total Received Data vs Node Id*

Fig. 8 represent the total packets transferred from source Node 5 to destination Nodes 4, 8 and from source Node 6 to destination Nodes 7 in terms of bytes. The value in bytes is used for theoretical calculations.

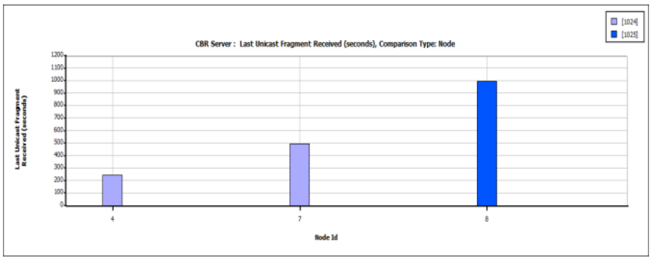

Fig .9. *Time of the last packet received vs Node ID*

Fig. 9 gives the information about when the last packet is received at the server in terms of seconds.

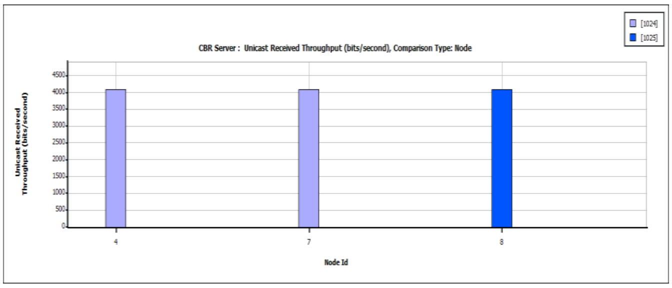

Fig. 10. *Received Throughput vs Node Id*

Fig. 10 shows Throughput vs. Node Id. From the figure it observed that at Node 4 throughput obtained is 4112.45bits/second, at the Node 7 throughput obtained is 4104.21bits/second and at the Node 8 throughput obtained is 4096.01bits/second. As the moving nodes improve the throughput value is decreased due to increase in traffic load. Section 3 gives the mathematical expression for the throughput using data reaches to the destination, time of last packet received and first packet received.

Data received at the destination Node 4= 128000*8 bits
Time of the first packet received at Node 4= 1 second
Time of the last packet received at Node 4= 250 second
Received throughput= (128000*8) / (250-1) = 4112.449 bits/second. From this analysis, it is observed that both theoretical and simulated parameters are equal.

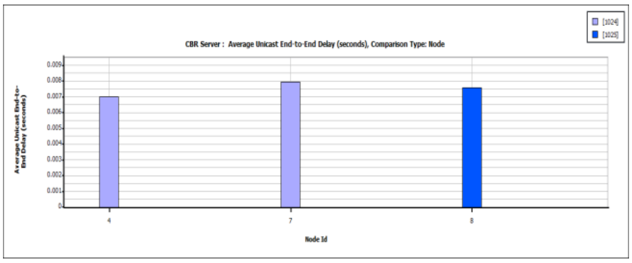

Fig. 11. *Average Unicast End to End Delay vs Node Id*

Fig. 11 illustrate that the end to end delay at Node 4 is 0.00704583 seconds, at Node 7 is 0.00799729 seconds and at Node 8 is 0.00759608 seconds. For the less number of mobile nodes the end to end delay is low, as nodes increases the end to end delay increased. From section 3 the mathematical expression for the end to end delay is considered by using time of the first packet received at the server and time of the first packet transmitted at the client.

Time of the first packet received at the Node 4= 1.00705
Time of the first packet transmitted from Node5 to Node 4= 1
End to End Delay = (1.00705-1) =0.00705 sec. It is observed that mathematically observed parameters are equal to the simulated values.

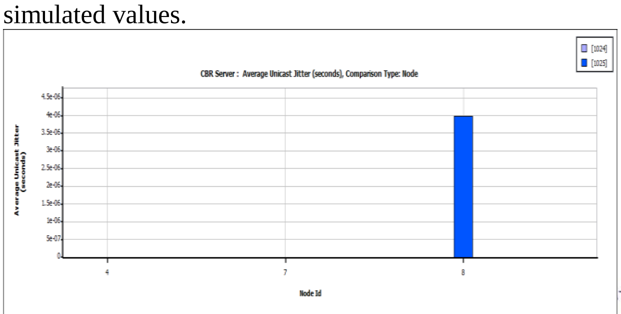

Fig. 12. Average Unicast Jitter

Fig.12 shows the value $6x10^{-09}$ seconds at Node 4 and $4.008x10^{-06}$ at Node 8. From the results it is shown clearly that there is no packet loss at the Node 7.

VI. CONCLUSION

In this mobility management in LTE networks are described by designing the horizontal handoff between two homogeneous (LTE-LTE) networks. For the designed network the performance consideration such as throughput, jitter, end-to-end delay are analyzed. The designed network provides the high throughput less delay due to loss less packet transmission. From the results it is observed that the jitter is very less and at Node4, Node8 and it is almost zero at the Node7 due to smooth handover between the mobile nodes there is no time deviation for the packets to reach the destination. The interconnection of LTE-LTE networks provides best QoS, Mobility and Coverage.

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