Performance Analysis of Handover in LTE (Long Term Evolution) Femtocell Network

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***Abstract*- Nowadays, the demands for high data rate in wireless communication are increasing and the system is expected will gradually towards to ultra-wide band technology in the next generation [2]. As the growing multimedia, wireless communication system faced the challenges to support broadband data access. According to the survey, the personal communications system is ninety percent occur indoor which also nearly two-thirds of the service. Therefore, in order to improve the coverage and to increase system capacity, the system operators cope with large demand for mobile devices. Femtocell is a mainstream solution which a popular method to extend mobile network coverage and to enhance the system capacity. A method that can be set up by both system operators and consumers also known as a home base stations, a small communication range, low power, low cost and other characteristics. The latest technology in wireless communication systems is Long Term Evolution (LTE) Femtocell with one of the purposes of this technology is to enhance indoor coverage by using 'plug and play' approach by the user as the operation of this technology to be achieved [1]. Telecommunications industry services are moving forward from circuit switched to packet-switched and from voice to data. LTE are ready to conquer the next generation of mobile networks. Some opinion feels that the LTE technology can give great economic benefits to the operators and the networks beyond 3G mobile. Long Term Evolution (LTE) are technologies toward next-generation mobile broadband standards, which is this technologies expected to provide higher throughput and lower transmission latency for mobile users [2]. By using femtocell technology there will be both good for users and system operators. For users, good signal enhance the transmission reliability, capacity, and offers energy saving features such as reduced electrical interference and power wasting. This function defines handover for emerging technologies and will add value to the network operator [1]. These papers do a Performance Analysis of Handover in LTE (Long Term Evolution) Femtocell Network. In order to know the performance analysis of handover in LTE femtocell network, four scenario are involved which is investigate scenario for handover with three femtocells (without handover), investigate scenario for handover with three femtocells (with handover), investigate scenario for handover with five femtocells (without handover) and investigate scenario for handover with five femtocells (with handover). This paper will explore the entire scenario by using LTE-Sim network simulator. All this scenario were analyze based on the performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE on a different femtocell which is three femtocell and five femtocell for different flows such as VoIP Packet Loss Ratio and VoIP Throughput by using LTE-Sim. This paper begins with a brief history and an overview of LTE (Long Term Evolution) technologies.**

***Keywords*- Long Term Evolution (LTE), Proportional Fair (PF), Voice over internet protocol (VoIP), LTE-Sim (LTE Simulaor)**

I. INTRODUCTION

Telecommunication technology moving faster which is network of wireless goes from analog to digital. From 1G to 2G and 3G comes along, and gives faster data transfer speed at least 200 kb/s. Actually it is a challenge to get truly and fully 4G connectivity. Lately, there is an increasing demand for Internet access from mobile devices. To overcome this problem, wireless telecommunication industry actually already fully effort to increase a system capacity, give better framework for broadband high mobility, give a better performance for cell edge, reduce latency and improve efficiency of spectral [3].

As a demand from the users, 3GPP formulated LTE which is a LTE femtocell to make the technology communication are more satisfying. The new technology proposed also known as Home Evolved Node B (HeNB) that is used for indoor environment. The aim of this technology is to increase the capacity and performance of the system as well as to achieve the high data rate successfully [4]. Similarly like other technologies, the interferences and challenges in the technology of femtocell cannot be avoided. The challenges that

might be occur in this technology such as Seamless Handover between a Femtocell and a Macrocell or Other Femtocells, Plug-and-Play Network Interoperability and Standardization, Synchronization and Location and Security, QoS Control over a Third Party Backhaul and Interference to/from Other Femtocells and Macrocell BSs [5]. The challenge is also to discover the best solution to boost the indoor signal coverage and keep high data rate services.

LTE (Long Term Evolution) is a technology which is a leading the pack to mold the next generation mobile network standard. Long-Term Evolution (LTE) has also been developed by an international organization that developed the widely used UMTS WCDMA / HSPA in 3G standards (3GPP). Since it is the use, release 8 was completed in 2010 and was followed by the release of 9. Currently LTE is defined as the release of 10 of the latest technology that has been deployed. Basically, LTE has been established as a standard upgrade to 3G. Each mobile carrier has embraced it as the next generation of 3G and recognized after its main benefits. Although still defines the 3GPP LTE as 3.9G technology, all current LTE network on 4G marketed [6].

Recently, the technology of femtocells is quite popular in the wireless technology system regards of the various interfere and challenges it faced. The challenges occur such as the proposed of integration architecture and access control management, security, mobility management, interference management and others [7]. To run this new technology successfully, system operators need to integrate the existing architecture such as GPRS, UMTS, LTE, WiMAX and other backbone internet which they will faced the integration between the original network and femtocell [8]. The system operators should manage a smooth interoperability within the networks, security, and network monitoring software, and integration application services system, standardization / equipment upgrades and also to work out on new and old equipment compatibility issues. In order to support the macrocell/femtocell integrated network, a handover procedures for existing networks are needed despite there are might be too many pre handover and unnecessary handover processes frequently occur because a large number of femtocells.

LTE (Long Term Evolution)

Long-Term Evolution (LTE) is a promising technology to allow a higher performances and Long-Term Evolution (LTE) can give a big impact to an economic benefits and great technology to mobile network operator's move beyond 3G. LTE can have a better advantage than an alternative wireless technologies are current now competing with a technology of 3GPP. LTE provides a cost-effective way to deliver to the user and with this technology that is directly based on existing 2G and 3G systems. Expected the same frequency band will be used for expected both LTE and legacy system which is GSM (Global System for Mobile Communications) and UMTS (Universal Mobile Telecommunications Service). It is because there are no specific for frequency bands for this technology of LTE. Every technology having its own concept including this LTE, which is to improve performance of a system in terms of a cost, coverage, processing latency and data rate [8].

FEMTOCELLS

Originally known as an Access Point Base Station which is a small cellular base station, Femtocells is typically designed for use in small business environments or residential. It is a small mobile tower at home and used to give licensed indoor coverage which it integrates the internet access technologies like DSL and cable with mobile technologies. Femtocells also can produce internal mobile radio signal and connect the operator via the internet. Femtocell is a cell in a cellular network that provides radio coverage which also known as a Home-BS or a Femto-Access Point (FAP)**.** It is a mini low-power BS installed by end users. FBSs offer enhanced data capacity, offload traffic from the Macro/Micro networks and also a better coverage. Therefore, it typically deployed indoors residential, Small Office Home Office (SOHO) and enterprise where access would otherwise be limited or unavailable. Basically have tens of meters of coverage range and can support up to ten active users in a residential setting, femtocells that operate in the licensed spectrum comes in a figure look like broadband modems [13].

In these paper, analysis were used 5x5 apartment grid which is the former consists in two buildings composed of two rows of 10 apartments each. The latter, instead, is a building composed of 25 apartments located over a 5x5 grid. Each building is identified by an unique ID and its position is defined into a Cartesian system. For both the aforementioned building types, it is possible to define the number of floors. Each apartment has a squared form and an area of 100m2. In general, each apartment contains up to one active femtocell, i.e., an active HeNB is working in the femtocell. This means that, for instance, a 5x5 grid building can contain up to 25

femtocells. But in these papers were analysis on three femtocells and five femtocells with a different handover scenario.

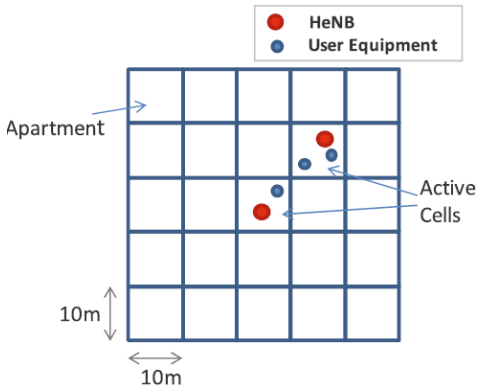

Figure 1: 5x5 apartment grid

HANDOVER MANAGEMENT

One of the main aims of LTE systems is to provide a fast and seamless handover from one cell (source cell) to another (target cell). Handover management is the key function by which wireless network support mobility and to maintain quality of service. Handover enables the network to maintain the UE's connection while it moves from the coverage area of one cell/sector to another. Handover is the process of transferring an ongoing voice call or data session from one cell connected to the Core Network to another [9]. Handover procedures for existing networks are needed to support the macrocell/femtocell integrated network. In a large number of femtocells, there are too many prehandover and unnecessary handover processes frequently occur. In order to has seamless mobility between femtocell and macrocell, it is necessary dedicated on designing appropriate handover strategy. In this paper will further discuss and analyze the handover in different femtocell based on the performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE for a different flow which is VoIP Packet Loss Ratio and VoIP Throughput by using LTE-Sim [10].

VoIP

This paper will explore the different scenario by using LTE-Sim network simulator. All these scenarios were analyze based on the performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE on a different femtocell for different flows such as VoIP Packet Loss Ratio and VoIP Throughput .

VoIP is a way of transmitting voice traffic as data packets over an IP network. Voice traffic is first transformed into digital signals then it is compressed and broken into a series of packets. These series of packets will later be reassembled and decoded at the receiver. Voice digitizing and encoding can either be done before or concurrently with packetization. This technology has grown rapidly due to different factors such as: low cost, the integration of voice and data traffic over the existing networking infrastructures [11]. Since our main aim is to analyze the performance analysis of handover in LTE, it is of great importance to analyze some important parameters that describe VoIP in LTE networks. These parameters will be investigated in the next sub section.

II. METHODOLOGY

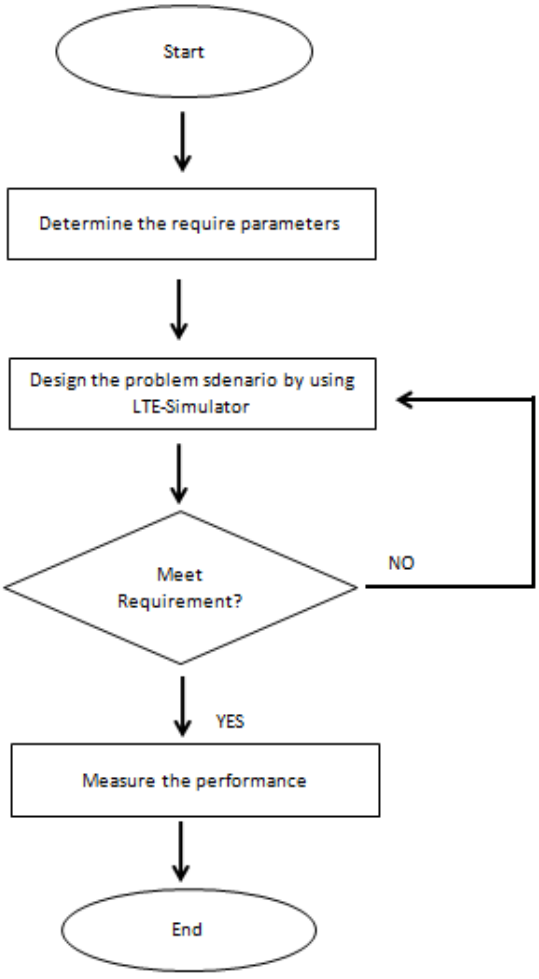

Figure 2: Methodology Process

III. MEASUREMENT SYSTEM AND SCENARIO SETUP

The simulation results were generated using the open source LTE system simulator called long term evolution-SIM (LTE-SIM). It models different uplink and downlink scheduling strategies in multicell/multiuser environments; taking into account user mobility, radio resource optimization, frequency reuse techniques, the adaptive modulation, and coding (AMC) module. It also includes other aspects that are relevant to the industrial and scientific communities [12].

LTE SIMULATOR (LTE SIM)

LTE-sim is an event-driven simulator written in C++ using the well-known object-oriented paradigm. It encompasses several aspects of LTE networks, including the models of both the E-UTRAN and the evolved packet system, downlink and uplink transmissions, single and multi-cell environments, QoS management, multiusers environment, user mobility, handover procedures, and frequency reuse techniques. Furthermore, the entire LTE protocol stack is framed from the application to the PHY layer, including radio resource control (RRC), radio link control, and MAC entities. This is done for the three kinds of network nodes, that is, UE, eNB, and Mobility Management Entity/Gateway. In addition, the software supports also well-known scheduling strategies (such as Proportional Fair, Modified Largest Weighted Delay First, and Exponential Proportional Fair, Log and Exp rules), Adaptive modulation and coding scheme, channel quality indicator (CQI) feedback, and several other aspects related to the LTE technology [12].

The high flexibility and modularity of LTE sim allowed us to devise a complete system for simulating LTE femtocells, built on top of existing features such as application objects, tracing, interaction among macrocells, interference computation, mobility, handover procedures, and so on. For these paper using this type of simulator to analyze the handover in LTE femtocells.

On these papers, the network is made by two different femtocells which is network with three femtocells and five femtocells and different handover occurred. All the simulations were run in 5x5 grid building with three femtocells and five femtocells. Most of the simulation parameters are presented in the table 1 below. VoIP flows are generated by the traffic generator in LTE-SIM called VoIP application. For these paper, having a two type of femtocell was investigate for handover analysis which is three and five femtocell that can be conclude by; on this project are in one simulation scenario there was no handover features implemented so the user speed was set to zero, this is equivalent to static position [13]. But in another simulation scenario, we implemented mobility features

IV. SIMULATION PARAMETER

A summary of the simulation parameters is given in Table I.

Table 1: Simulation Parameter

Simulation Parameters	Values
Radius	1km
Number of Users	3
Min of User	1
Interval	1
Max user	3
Femtocell Building	3
nBuilding	25 (5x5 grid)
Apartment Side	10m
Mobility pattern	Random direction & random walk
Number of femto	3 and 5 based on scenario
Bandwidth	5 Hz

V. ANALYSIS OF SIMULATION RESULT AND DISCUSSION

Our main aim is to do a Performance Analysis of Handover in LTE (Long Term Evolution) Femtocell Network it also importance to analyze the effect of mobility and handover to the QoS of voice traffic, it is of great importance to analyze some important parameters that describe QoS of voice in LTE networks.

In these papers more focus on four scenarios in handover which are:

1) Investigate scenario for handover with three femtocells (without handover)
2) Investigate scenario for handover with three femtocells (with handover)
3) Investigate scenario for handover with five femtocells (without handover)
4) Investigate scenario for handover with five femtocells (with handover)

All this scenario were analyze based on the performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE are performed on a different femtocell which is three femtocell and five femtocell for different flows such as VOIP Packet Loss Ratio and VOIP Throughput by using LTE-Sim. The performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE are performed on a different femtocell for different flows such as VOIP Packet Loss Ratio and VOIP Throughput.

In a handover scenario, every subscriber moves with a constant speed km/h in random directions which is in a random walk. The random direction model is being used; the user chooses the speed direction at random and keeps the same speed while moving towards the simulation boundary area. When the user reaches the simulation boundary area then new speed direction can be chosen. In contrary, when the random walk model is chosen, user chooses the speed direction at random but keeps moving at that speed for a specific travel distance depending on that speed. The user only changes the speed direction if the distance is covered or once the simulation boundary is reached [13].

1) Investigate scenario for handover with three femtocells (without handover) and Investigate scenario for handover with three femtocells (with handover)

First these papers measured the packet loss ratio which is the rate at which VoIP packets were dropped during voice traffic transmission while gradually increasing the number of VoIP users. This is shown in Fig.2 which is scenario for handover activated with 3 femtocells and Fig.3 scenario for handover deactivated with 3 femtocells.

The packet drop ratio is measured and plotted on the Y axis as increased the number of VoIP user steadily to the maximum of three users. As it can be seen in Fig.2, handover had a significant impact on voice traffic in Proportional Fair (PF) scheduling algorithms. There was a higher packet loss ratio in Proportional Fair (PF) scheduling algorithms with handover features compared to Fig.3 those without handover features.

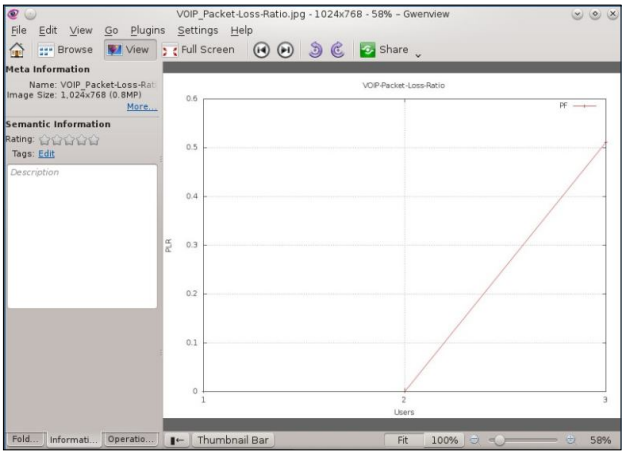

Figure 2: VoIP Packet Loss Ratio for scenario with handover (Three femtocells)

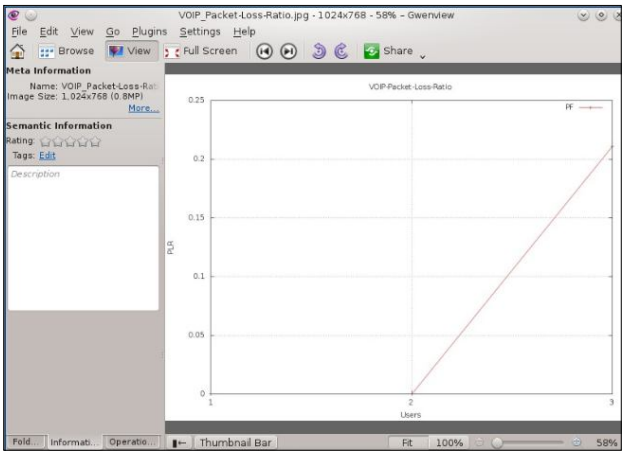

Figure 2: VoIP Packet Loss Ratio for scenario without handover (Three femtocells)

These papers also measured throughput while using the scheduling algorithms for all scenarios. This is shown in Fig.4 and Fig.5 As it can be seen, throughput increased as the number of VoIP users increased in Proportional Fair (PF) scheduling algorithms for both scenarios. Different with this scenario, it is because; there was a higher throughput without handover compared to those handover.

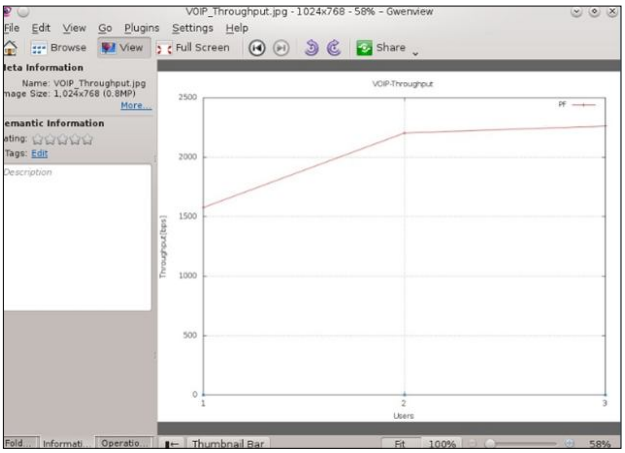

Figure 4: VOIP Throughput for scenario with handover (Three femtocells)

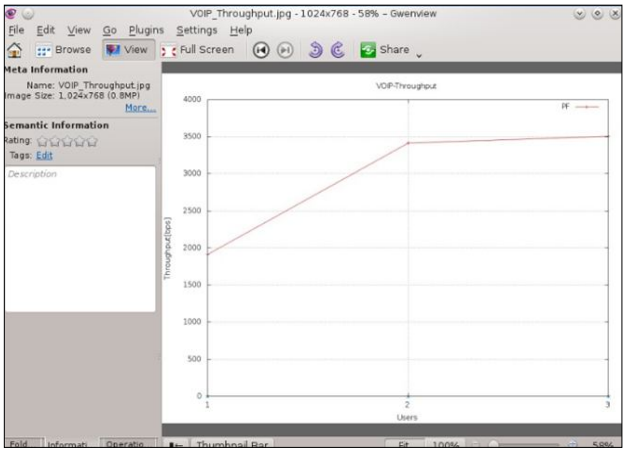

Figure5: VOIP Throughput for scenario without handover (Three femtocells)

2. Investigate scenario for handover with five femtocells (without handover) and Investigate scenario for handover with five femtocells (with handover)

For this scenario still to see the performance evaluation of Proportional Fair (PF) scheduling algorithms in LTE are performed on a five femtocell that consist femtocell with handover and without handover in VOIP Packet Loss Ratio and VOIP Throughput. This is two important criteria in a handover management.

As it can be seen in Fig.6 there was a data not in a constant reading of packet loss ratio in Proportional Fair (PF) scheduling algorithms. It is because mobility was happen here as compared to Fig.7, which is the data of packet loss ratio in Proportional Fair (PF) scheduling algorithms slightly decrease as the number of user increase. This is mainly due to the fact that some VoIP packets were being dropped as the number of users was being increased. It is also means that the number of lost packets through the network while transmitting the VoIP signal goes down with the increase of the users.

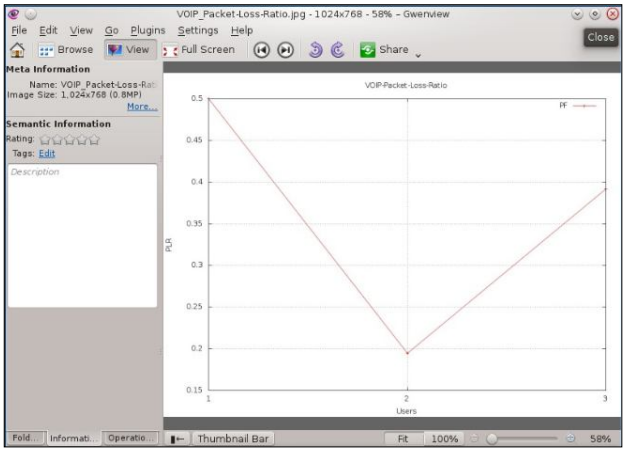

Figure 6: VOIP Packet Loss Ratio for scenario with handover (Five femtocells)

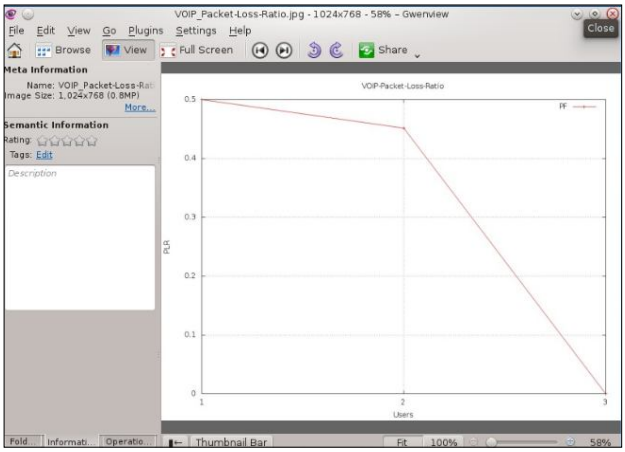

Figure 7: VOIP Packet Loss Ratio for scenario without handover (Five femtocells)

The throughput for the VoIP flows is given on Fig.8 and Fig. 9. It can be noticed that throughput for the VoIP flows in LTE for both scenario which is femtocell with handover and femtocell without handover is increasing with the increase of the number of users. There was a higher throughput without handover compared to those handover.

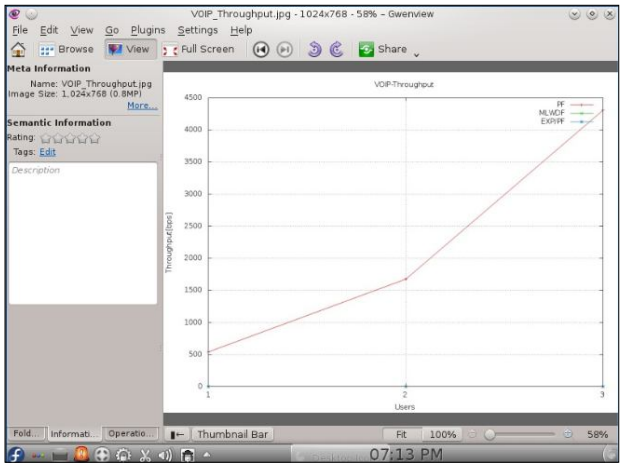

Figure 8: VoIP Throughput for scenario with handover (Five femtocells)

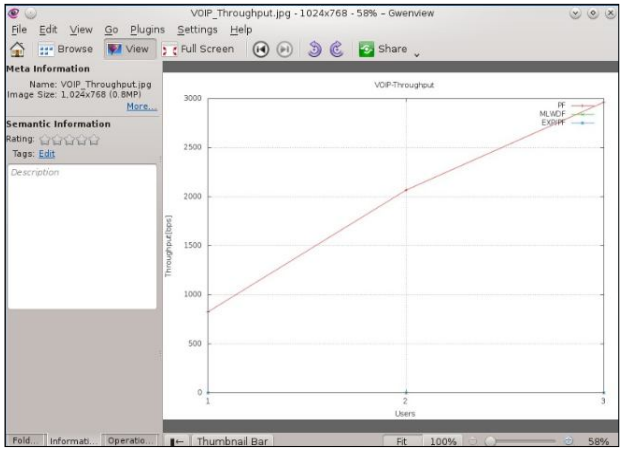

Figure 9: VoIP Throughput for scenario without handover (Five femtocells)

From all the above it can be concluded that:

- There was a higher VoIP throughput without handover compared to with handover for both scenario which is three femtocell and five fetocell.
- In handover scenario, there was a higher packet loss with handover or mobility features compared to those without mobility features for both scenario which is three femtocell and five femtocell.
- Throughput and packet loss is important key in handover management.

VI. CONCLUSION

One of the main aims of LTE systems is to provide a fast and seamless handover from one cell (source cell) to another (target cell) which is from one femtocell (source cell) to another femtocell (target cell). As we know, Long Term Evolution (LTE) becoming the latest technology in wireless communication systems. So, these paper aims to do a Performance Analysis of Handover in LTE (Long Term Evolution) Femtocell Network. By using the LTE-SIM simulator, were able to compare all the criteria in four different scenarios which are:

1) Investigate scenario for handover with three femtocells (without handover)
2) Investigate scenario for handover with three femtocells (with handover)
3) Investigate scenario for handover with five femtocells (without handover)
4) Investigate scenario for handover with five femtocells (with handover)

Table 2: Conclusion Analysis Simulation

		HANDOVER ACTIVE	HANDOVER NON ACTIVE
PACKET LOSS	3 FEMTOCELLS	HIGHER	LOWER
	5 FEMTOCELLS	HIGHER	LOWER
THROUGHPUT	3 FEMTOCELLS	LOWER	HIGHER
	5 FEMTOCELLS	LOWER	HIGHER

This is mainly due to the fact that some VoIP packets were being dropped as the certain number of users.

VII. FUTURE DEVELOPMENT

Long Term Evolution (LTE) is expected to satisfy the market needs for next decade. However, user expectations, traffic growth and new services will demand more and more from the network in the future. For the future development research on evaluation handover analysis in LTE can be applied. It can be focus on the large femtocell with the higher of users which is Handover from HeNB to macrocell (hand-out) and Handover from macrocell to HeNB (hand-in)

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