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Energy Management in Long Term Evolution-Advanced(LTE-A) with Relay Nodes

B.Shoba[1],S.Ezhilarasi [2],S.Sabhitha[3],I.Sushmitha @ Asha[4]

[1]Department of Electronics and Communication Engineering,Rajiv Gandhi College of Engineering and Technology

[2]Department of Electronics and Communication Engineering,Rajiv Gandhi College of Engineering and Technology

[3]Department of Electronics and Communication Engineering,Rajiv Gandhi College of Engineering and Technology

[4]Department of Electronics and Communication Engineering,Rajiv Gandhi College of Engineering and Technology

Abstract — *In the Long Term Evolution (LTE) network, buffer overflows often occur in the evolved Node B (eNB) when dealing with the traffic bursts from the wired part due to restricted bandwidth or environmental interferences in the wireless part,so we consider a LTE-A network to enhance the system. In this project, a novel approach Energy Management in LTE-A network with relay node model is proposed to increase the coverage area to a greater extend and accommodate more number of users.To reduce the losses and increase the coverage area,relay model is introduced in the LTE-A network and also to increase the efficiency of the network.To evaluate the suggested solution, a LTE-A network with relay model is implemented,It is demonstrated that the proposed approach can enhance the end to end system performance in terms of network throughput, average packet delay as well as packet delivery ratio.*

Keywords*- long term evolution-advanced, coverage area, relay node, network simulator, packet delivery ratio, throughput, end-to-end delay*

I.INTRODUCTION

OFDM is also robust against selective fading, as the fading may affect only few carriers in the spectrum. In such scenarios the OFDM allocates the user with the best quality carrier, ie., the frequency which is not affected by fading. More bandwidth can be allotted simple by scheduling more subcarriers. The subcarriers are separated by 15kHz in frequency domain (3GPP TS 36.211). The LTE-A UE is expected to support a minimum of 12 subcarriers from contiguous band of 180 kHz. The bandwidths supported by LTE-A release 8 are 1.4, 3, 5, 10, 15, and 20MHz. Modulation supported by OFDM is the Quadrature Phase Shift Keying (QPSK), 16 Quadrature Amplitude Modulation (16QAM) and 64QAM.The two different symbols sent on the same subcarrier may reach receiver at the same time and overlap each other due to multipath propagation which causes inter symbol interference (ISI). To prevent ISI, OFDMA uses the Cyclic Prefix(CP) which is inserted at the beginning of each symbol. It is a small portion of the signal copied form the end of the packet. The Peak-to-Average Ratio (PAPR) of the OFDMA makes the design of Radio Amplifier difficult where high PAPR requires more power. Since the UE works on a limited power from a battery, OFDMA is used only for the downlink transmission and not for the uplink transmission form the UE to eNodeB. The LTE-A uses the SC-FDMA for the uplink transmission and is described in the next section.

1.1 Relay Technology

The Relay Node concept in itself isn't new. At first, it was designed as simple radio repeaters that were receiving, amplifying the basestation's signals and were diffusing them with all their noise and imperfections. But the LTE Relay Node (RN) is more than a simple repeater as it extracts the data from the received signal, applies the noise correction techniques and retransmits the new "clean" signal in its own coverage zone. So basically, instead of only repeating the signal, the relay node also increases the signal quality.The Relay Node and the femtocell are low-power (low coverage) basestations. The femtocell is mostly used for indoor coverage (residential or commercial), usually for use cases where one wants the coverage to be limited to the zone that is supposed to be covered, in order to avoid interference with the wireless communications happening in the surrounding areas. The particularity of the femtocell is that it is deployed without any coordination with the closest macro-cellular base station. That said, a wired connection to Internet is mandatory (optical fiber, DSL,…) to connect to the core network of the service provider. On the other end, the RN is connected to a macro eNodeB (basestation in LTE) called Donor eNodeB (DeNB) using a radio interface, which is a modified version of the Uu interface (usual interface between an eNodeB and the UE / cellphone).The DeNB not only shares its radio resources with the RN, but it also continues to deserve its own UEs. For a Donor eNB, the relay node appears as a UE, just as in return a RN sees the DeNB as an eNB, a Mobility Management Entity (MME) and a Signal Gateway (S-GW). By creating its own coverage zone, the RN appears as aeNB to the UEs. Consequently, the RN supports the functionalities of the eNB: it ends the protocols of the E-UTRA radio interface, the S1 (between eNB and MME) and X2 (between 2 eNBs) interfaces and a part of the UE functionalities like the physical layer, the 2nd layer and

RRC that allows to connect wirelessly to a DeNB.LTE-A relay node, are designed to be low cost and lower power nodes which can be easily and quickly deployed when needed. They can be deployed in several scenarios: in rural areas to enhance the coverage, urban hotspot to enhance the capacity in order to cope with the high user density, group mobility to deserve users on public transportation, indoor hot spots to achieve high data throughput, etc.

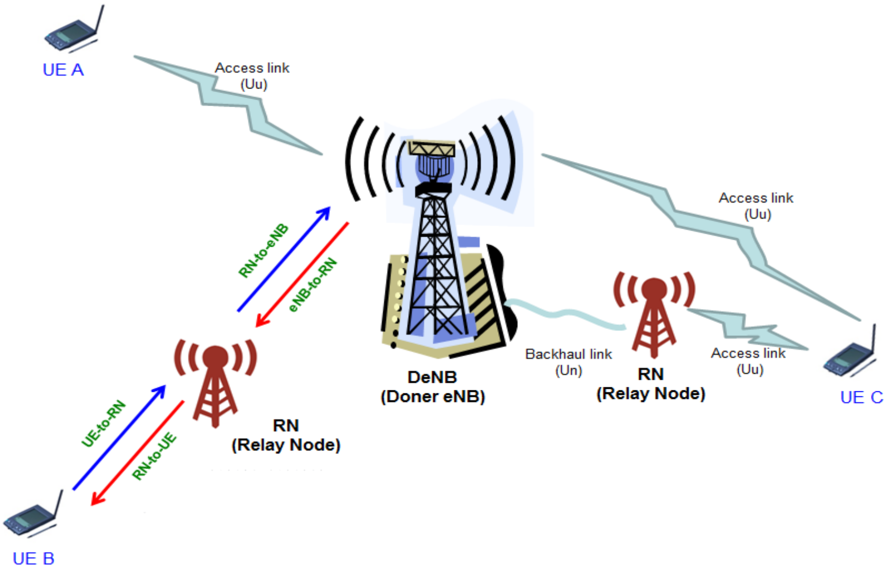

Figure 1.Relay Technology

1.2 LTE-Advanced

LTE Advanced (LTE-A) is an enhancement of the 3GPP LTERelease 8. LTE-A is the formally submitted 4G candidate to the ITU-T. LTE-A is standardized in the 3GPP release 10 in late 2009. The LTE-A is covered in the 3GPP Release 10 and beyond. This Makes the LTE-A satisfy the minimum requirement of the IMT-Advanced, the ITU-R (International Telecommunication Union – Radio Communication) standard .The 3GPP Technical Report 36.913 details the list of requirements to be satisfied by the LTE-A standard.The LTE Advanced standard mainly focuses on higher capacity than LTE.

1.3 Self-Organising Network

The self-organizing network (SON) is a technology supported on the LTE-A networks. Which makes the planning, configuration, management, optimization and healing automated. This makes the LTE-A more simpler and faster. The SON can be classified in to three different types based on the architecture.

- **Distributed SON:** The SON functionalities are distributedacross the access nodes, mostly in the eNodeB. This involves some of the localized functions supplied by the equipment manufacturer.
- **Centralized SON**: In the centralized SON the functions areimplemented in the top nodes in the hierarchy, like the Operation Support Systems (OSS).
- **Hybrid SON:** This is a mix of the centralized and distributedSON.

The functions of the SON are classified into three different categories. Each of this sub functions are described in the 3GPP TS 36.902. Summary of SON functions are listed below.

- **Self-Configuration:** The self-configuration function aims atmaking the configuration operations "plug-and-play". With this the base station will be configured automatically and connected to the network. This includes configuration of the parameters and download of the software.
- **Self-Optimization:** This function handles hundreds ofconfiguration parameters of the eNodeB and optimizes the configurations based on the measurements done by the eNodeB and the UE.
- **Self-Healing:** The Self-healing function aims at managing thecause of the failed nodes in the network. This function will adjust the parameters in the cell so that the users are supported by working nodes.

II.EXISTING SYSTEM

Device-to-device (D2D) communication is a promising technique for traffic offloading in next generation cellular systems. However, the use of only direct D2D communications limits the advantages of D2D communications due to relatively long separation distances or poor link quality between source and destination user equipments (UEs). Relay-assisted D2D communication was proposed as a supplement to direct D2D communications for enhancing traffic offloading capacity in LTE-A systems. This work aims to design a relay UE selection strategy for D2D communications, which improves D2D communication performance significantly. We propose a cross-layer relay selection scheme that considers several criteria jointly, including end-to-end data rate, relay-capable UE (RUE) remaining battery time, and end to-end transmission delay on relay-assisted D2D path. We show how to leverage these criteria at an eNB performing relay selection in D2D communications. In particular, an end-to-end delay estimation model is established based on queuing theory. Simulation results validate the performance of the proposed scheme in terms of total amount of data transmitted under RUE remaining battery and end-to-end transmission delay.In this paper, we designed an efficient relay selection scheme for relay-assisted D2D communication in LTE-A systems. Under the assumption that D2D communications reuse the uplink channels of CUEs, we proposed a cross-layer relay selection scheme, which jointly considered the end-to-end data rate, RUE remaining battery time, and end-to-end transmission delay of relay-assisted D2D path. The estimation processes of the end-to-end data rate, RUE remaining operation time within its RBC, and end-to-end transmission delay were described. Specially, we established a packet queuing and retransmission analytical model for each link of relay-assisted D2D path, offering eNB the capability to estimate the transmission delay in each relay-assisted D2D path. Simulation results showed that, compared to other relay selection schemes, the proposed scheme offers the best overall transmission performance.

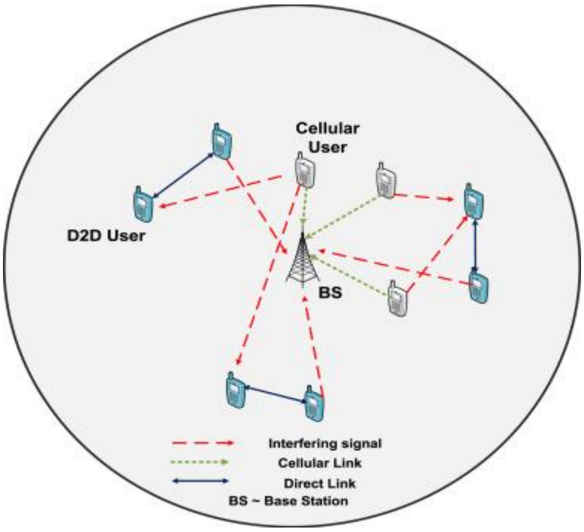

Figure 2.D2D Communication with user equipment

III.PROPOSED SYSTEM

3.1 Introduction

In the Long Term Evolution (LTE) network, buffer overflows often occur in the evolved Node B (eNB) when dealing with the traffic bursts from the wired part due to restricted bandwidth or environmental interferences in the wireless part. In this project, a novel approach Energy Optimization in LTE-A network with relay node model is proposed to protect the buffer from overflow when the buffer becomes congested and also to increase the efficiency of the network.To reduce the losses and increase the coverage area,relay model is introduced in the LTE-A network and also to increase the efficiency of the network.To evaluate the suggested solution, a LTE-A network model is implemented and validated through extensive numerical experiments. It is demonstrated that the proposed approach can enhance the end to end system performance in terms of network throughput, average packet delay as well as packet delivery ratio.

3.2 LTE-Advanced Network Formation

LTE Advanced is a mobile communication standard and a major enhancement of the Long Term Evolution (LTE) standard. It was formally submitted as a candidate 4G system to ITU-T in late 2009 as meeting the requirements of the IMT-Advanced standard, and was standardized by the 3rd Generation Partnership Project (3GPP) in March 2011 as 3GPP Release 10. The mobile communication industry and standards organizations have therefore started work on 4G access technologies, such as LTE Advanced. One of the important LTE Advanced benefits is the ability to take advantage of advanced topology networks; optimized heterogeneous networks with a mix of macrocells with low power nodes such as picocells, femtocells and new relay nodes. The next significant performance leap in wireless networks will come from making the most of topology, and brings the network closer to the user by adding many of these low power nodes LTE Advanced further improves the capacity and coverage, and ensures user fairness. LTE Advanced also introduces multicarrier to be able to use ultra wide bandwidth, up to 100 MHz of spectrum supporting very high data rates. The main new functionalities introduced in LTE-Advanced are Carrier Aggregation (CA), enhanced use of multi-antenna techniques and support for Relay Nodes (RN). The new functionalities introduced in LTE Advanced are Carrier

Aggregation (CA,) enhanced use of multi-antenna techniques, and support for Relay Nodes. All of these are designed to increase the stability, bandwidth, and speed of LTE networks and connections.

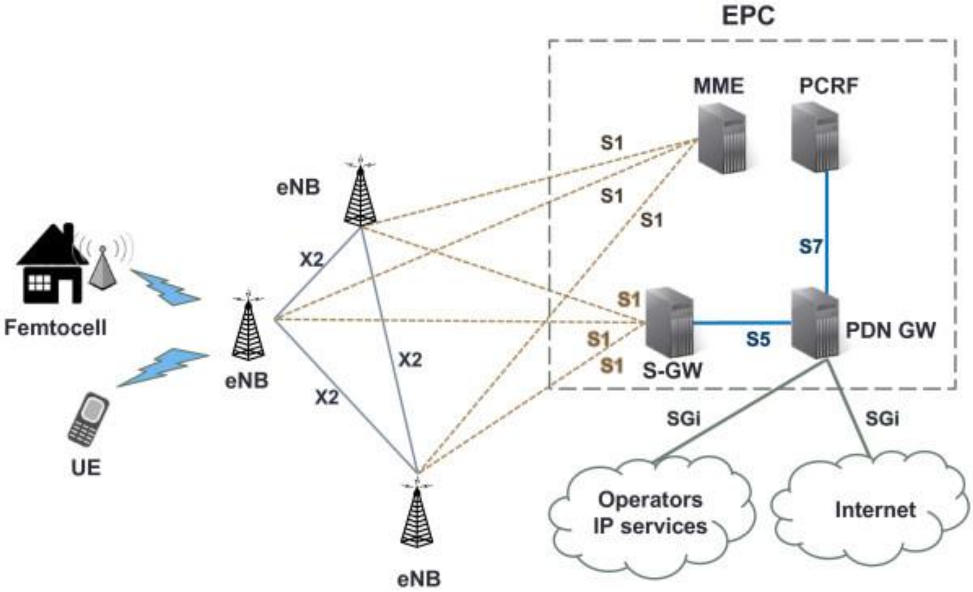

Figure 3.LTE Network

3.3 Relay Nodes in LTE

Relay nodes are connected to the eNodeB for coverage to avoid buffer overflow because they offer simple transmission.There is no problem in accommodating large number of users due to the usage of relay concept.Packets are delivered in between the relay nodes with a packet delivery ratio.

- Increase in network density-LTE relay nodes can be deployed very easily in situations where the aim is to increase network capacity by increasing the number of eNodeBs to ensure good signal levels are received by all users.
- Network coverage extension-Additionally LTE relay nodes may be sued to increase the coverage outside main area. With suitable high gain antennas and also if antenna for the link to the donor eNodeB is placed in a suitable location.It will be able to maintain good communications and provide the required coverage extension.
- Rapid network roll-out-Without the need to install backhaul, or possibly install large masts, LTE relays can provide a very easy method of extending coverage during the early roll-out of a network. More traditional eNodeBs may be installed later as the traffic volumes increase.

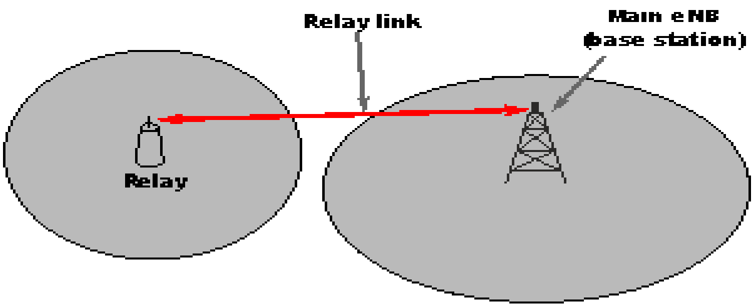

Figure 4.Relay node in LTE-A

IV.PERFORMANCE ANALYSIS

4.1 Performance analysis

- **Packet Delivery Ratio**- The packet delivery ratio, being one of the crucial factors in wireless communication, where the ratio indicates the amount of data received successfully in comparison with the total packet received. The result explains the fact that the information are being transferred in much reliable way than the existing protocols as MAC have the ability to separate the information priority wise and thus being able to reach the destination in the reliable route. The simulation shows different color for different protocols, the simulation time is for 120 seconds with 100 nodes at any instant.

- **Average End to End Delay**- The average end to end delay is delay between the data transmitted and received by the destination.
- **Residual energy**- The residual energy is amount of energy left in the node after every few instance. The initial energy of each node is 100 joules, after that there is energy reduction seen as time passes. The energy is lost due to transmission, route discovery, priority checking, and reception and found that this protocol is efficient as it consumes lesser energy.
- **Overhead**-By the use of different layers,the overhead is reduced in this system.Overhead resource elements in LTE-A networks are used for some control, signaling and synchronization tasks at both the Physical level and Media Access Control sub-level.
- **Data Transmission**-The data rate is well boosted in this system and also improves the dependability of wirelesslink.The data rate actually used or achieved with LTE-A depends on several features: channel bandwidth, modulation type, MIMO configuration, and the quality of the wireless path.
- **Throughput**-Throughput or network throughput is the rate of successful message delivery over a communication channel. The data these messages belong to may be delivered over a physical or logical link, or it can pass through a certain network node.

4.2 Simulation Results

The average end to end delay is delay between the data transmitted and received by the destination. By the use of different layers,the overhead is reduced in this system.Overhead resource elements in LTE-A networks are used for some control, signaling and synchronization tasks at both the Physical level and Media Access Control sub-level. The data rate is well boosted in this system and also improves the dependability of wirelesslink.The data rate actually used or achieved with LTE-A depends on several features: channel bandwidth, modulation type, MIMO configuration, and the quality of the wireless path. The packet delivery ratio, being one of the crucial factors in wireless communication, where the ratio indicates the amount of data received successfully in comparison with the total packet received. The result explains the fact that the information are being transferred in much reliable way than the existing protocols as MAC have the ability to separate the information priority wise and thus being able to reach the destination in the reliable route. Throughput or network throughput is the rate of successful message delivery over a communication channel. The data these messages belong to may be delivered over a physical or logical link, or it can pass through a certain network node.

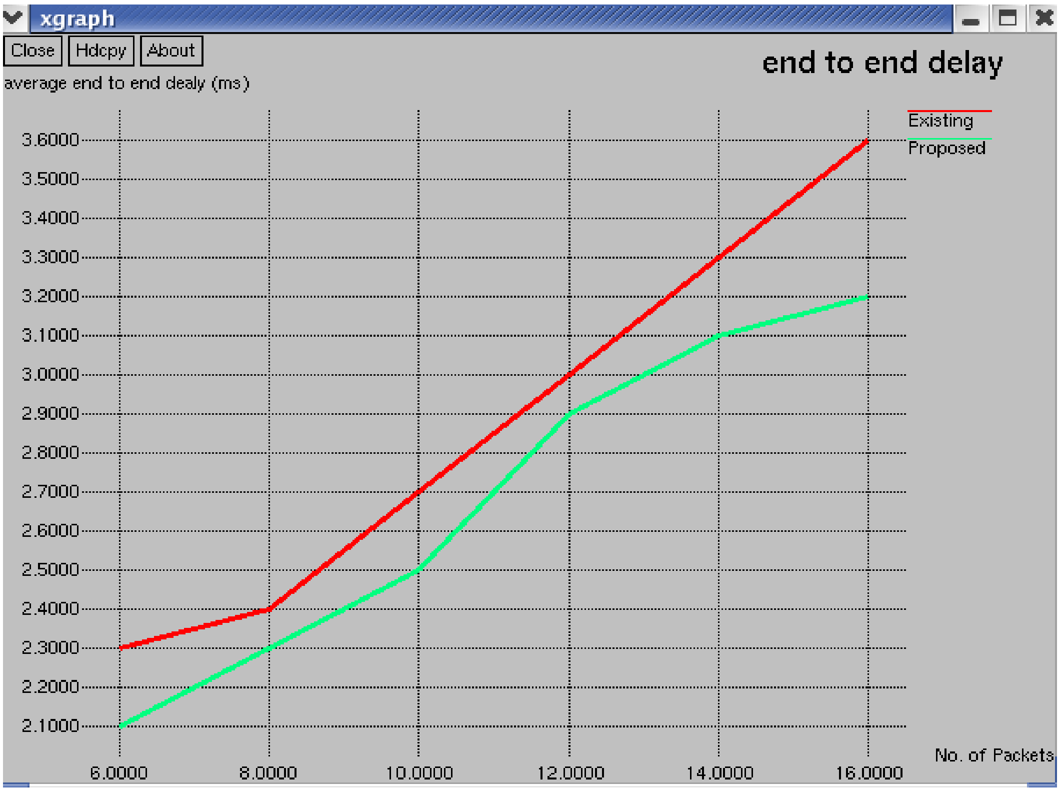

Figure 5.End-to-end delay

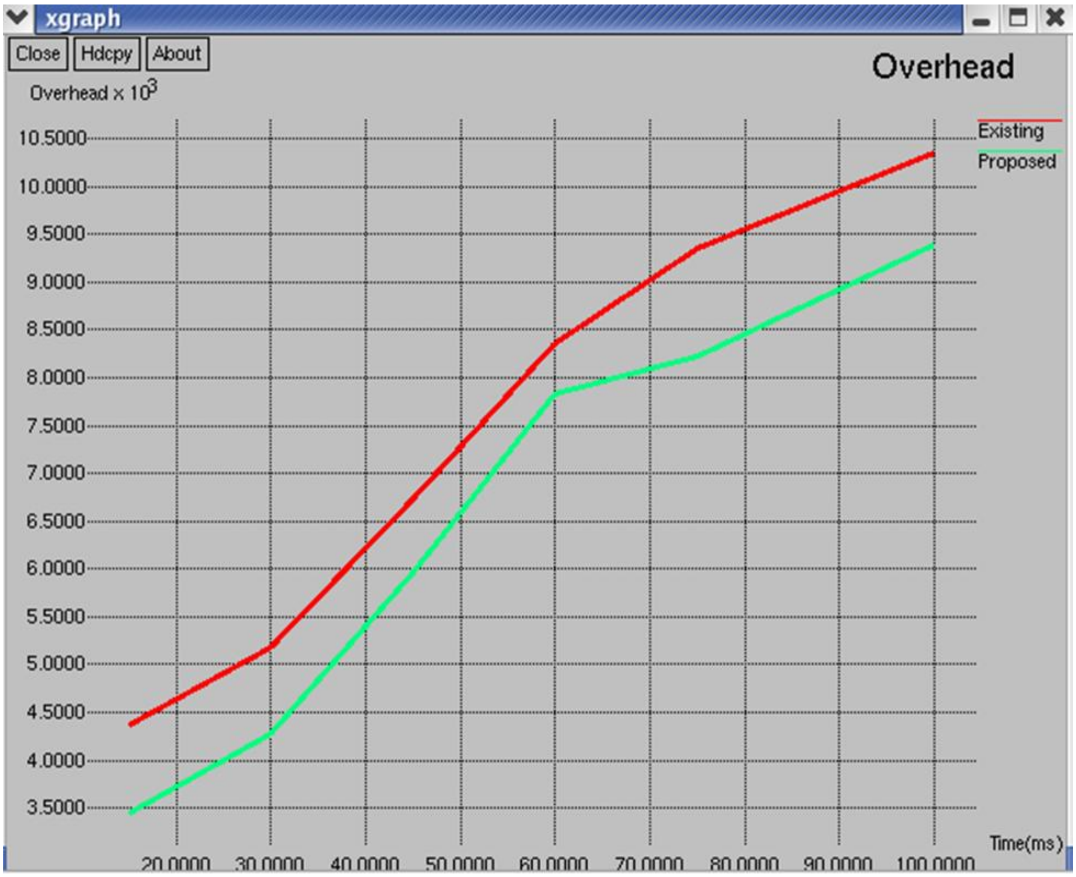

Figure 6.Overhead

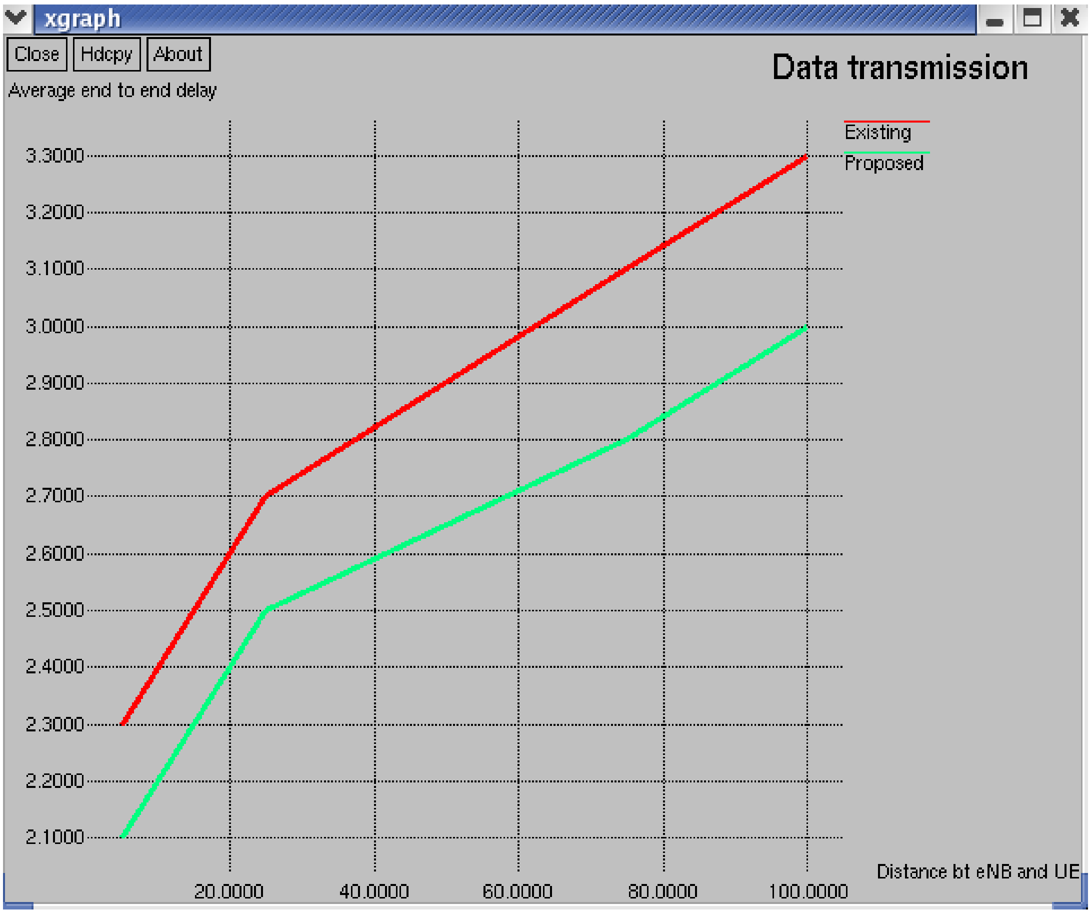

Figure 7.Data transmision

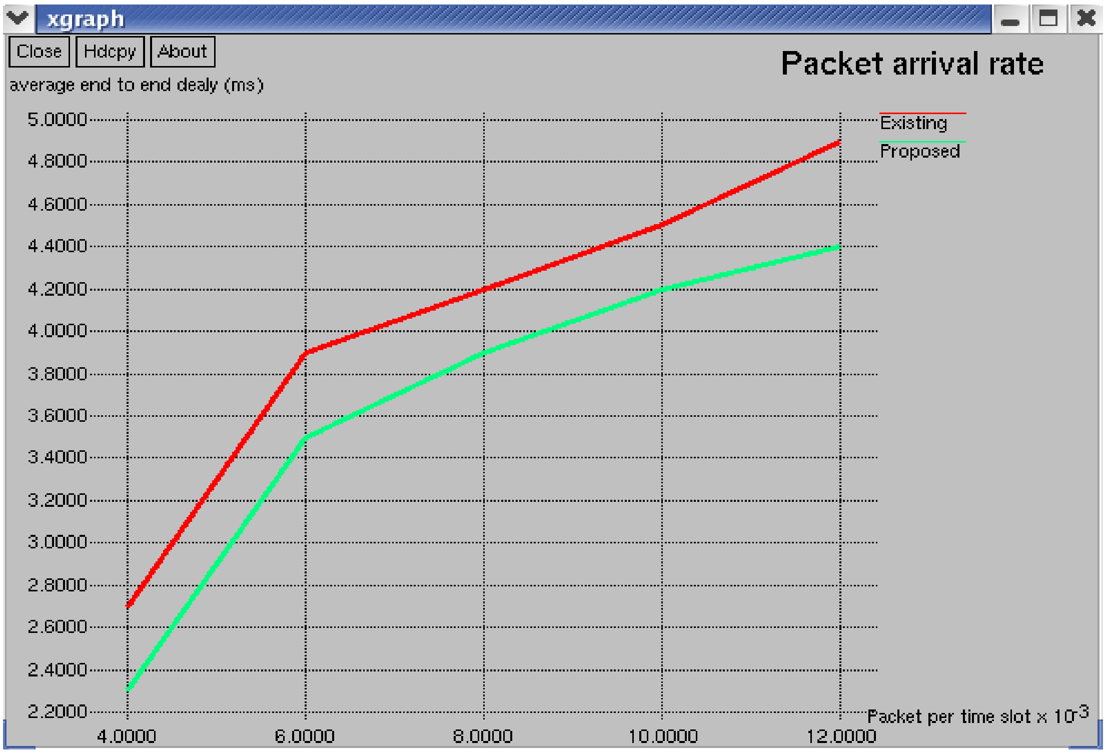

Figure 8.Packet arrival rate

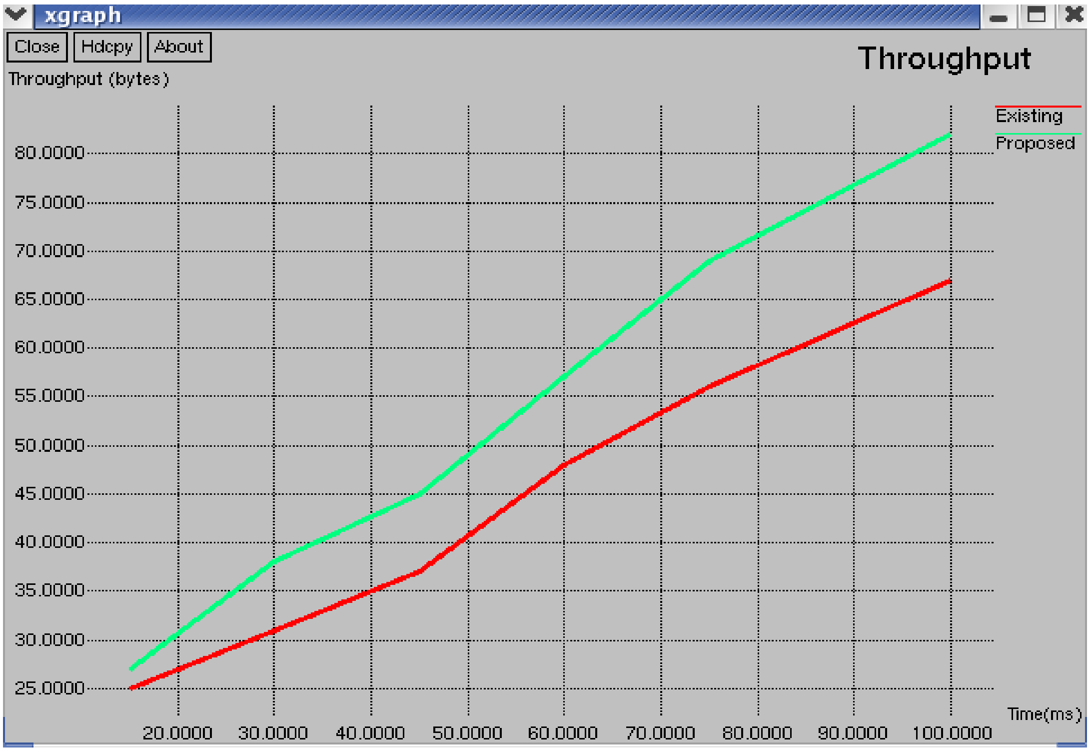

Figure 9.Throughput

V.CONCLUSION

Relay concept has made the information to be transferred in a reliable route with the packet delivery ratio.The average end to end delay in between the data transmitted and received by the destination has been eliminated by this approach.Through the usage of relay technology,there is an extension in the coverage area and increase in the network density.LTE-A technology has made the data to be transmitted in a better way by improving the data rate and the speed of transision.It is found that this is efficient as it consumes lesser energy. Through this system, there is improvement in the allotment of users, end-to-end delay, overhead, data transmission, packet delivery ratio, throughput and increase in the efficiency of the network.

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