Improved QoS in 4G using Firefly optimization

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Abstract*— In the current research the enhancement of the secured MANET routing protocol is done. The 4G uplink and downlink scheduling is chosen for enhancement due to the low QOS. Encryption is quite an important parameter in the MANET. To make PROPOSED more secure 3d cryptography technique is implemented in it for secure transmission. By applying the encryrption technique in the PROPOSED, sometimes the overheads are introduced in it. To overcome the problem of data dropped, load and encryption overheads in the network, an optimization technique called Adaptive ACO are used. Using the above mentioned optimization technique the data dropped and the losses in the network are reduced to some extent. The above defined results have shown the parameters that are improved using a network simulator called MATLAB. The PROPOSED generates much load on the network and the packets start delayed in network. This problem is reduced in the proposed approach using an optimization technique which makes multiple paths to the packets that are sent to the destination. By using the exactly reciprocal path the network can send data through multiple paths and the load in the network can be reduced.

***Keywords*— 4G, QoS, Firefly.**

I. INTRODUCTION

A computer network or data network is a telecommunications network which allows nodes to share resources. In computer networks, networked computing devices exchange data with each other using a data link. The connections between nodes are established using either cable media or wireless media. The best-known computer network is the Internet. Network computer devices that originate, route and terminate the data are called network nodes.[1] Nodes can include hosts such as personal computers, phones, servers as well as networking hardware. Two such devices can be said to be networked together when one device is able to exchange information with the other device, whether or not they have a direct connection to each other.

Computer networks differ in the transmission medium used to carry their signals, communications protocols to organize network traffic, the network's size, topology and organizational intent. Computer networks support an enormous number of applications and services such as access to the World Wide Web, digital video, digital audio, shared use of application and storage servers, printers, and fax machines, and use of email and instant messaging applications as well as many others. In most cases, application-specific communications protocols are layered (i.e. carried as payload) over other more general communications protocols.

II. MOBILE GENERATION

From the early analog mobile generation (1G) to the last implemented third generation (3G) the paradigm has changed. The new mobile generations do not pretend to improve the voice communication experience but try to give the user access to a new global communication reality. The aim is to reach communication ubiquity (every time, everywhere) and to provide users with a new set of services. The growth of the number of mobile subscribers over the last years led to a saturation of voice-oriented wireless telephony. From a number of 214 million subscribers in 1997 to 1.162 millions in 2002 [1], it is predicted that by 2010 there will be 1700 million subscribers worldwide [2] (see Figure 1). It is now time to explore new demands and to find new ways to extend the mobile concept. The first steps have already been taken by the 2.5G, which gave users access to a data network (e.g. Internet access, MMS - Multimedia Message Service). However, users and applications demanded more communication power. As a response to this demand a new generation with new standards has been developed - 3G. In spite of the big initial euphoria that evolved this technology, only one 3G network exists in commercial use today. This network has been deployed in Japan in 2001 using international standard IMT-2000, with great success.

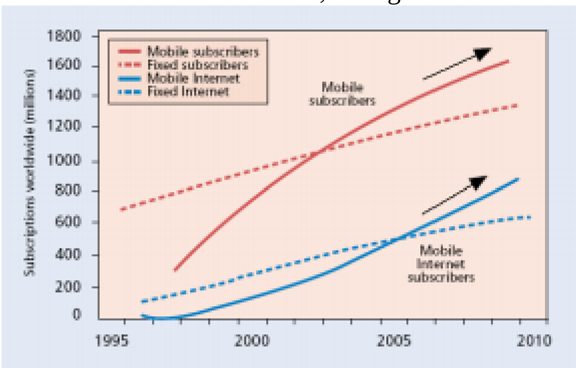

Figure 1 – Evolution of mobile and fixed subscribers [10]

In the last years, benefiting from 3G constant delays, many new mobile technologies were deployed with great success (e.g. Wi-Fi). Now, all this new technologies (e.g. UMTS, Wi-Fi, Bluetooth) claim for a convergence that can only be achieved by a new mobile generation. This new mobile generation to be deployed must work with many mobile technologies while being transparent to the final user.

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III. 4G LTE

Long-Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals, based on the GSM/EDGE and UMTS/HSPA technologies. It increases the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its Release 8 document series, with minor enhancements described in Release 9. LTE is the upgrade path for carriers with both GSM/UMTS networks and CDMA2000 networks. The different LTE frequencies and bands used in different countries mean that only multi-band phones are able to use LTE in all countries where it is supported.

LTE stands for Long Term Evolution and is a registered trademark owned by ETSI (European Telecommunications Standards Institute) for the wireless data communications technology and a development of the GSM/UMTS standards. However, other nations and companies do play an active role in the LTE project. The goal of LTE was to increase the capacity and speed of wireless data networks using new DSP (digital signal processing) techniques and modulations that were developed around the turn of the millennium. A further goal was the redesign and simplification of the network architecture to an IP-based system with significantly reduced transfer latency compared to the 3G architecture. The LTE wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate radio spectrum.

The objective of the 3G was to develop a new protocol and new technologies to further enhance the mobile experience. In contrast, the new 4G framework to be established will try to accomplish new levels of user experience and multi-service capacity by also integrating all the mobile technologies that exist (e.g. GSM - Global System for Mobile Communications, GPRS - General Packet Radio Service, IMT-2000 - International Mobile Communications, Wi-Fi - Wireless Fidelity, Bluetooth).

In spite of different approaches, each resulting from different visions of the future platform currently under investigation, the main objectives of 4G networks can be stated in the following properties:

- Ubiquity;
- Multi-service platform;
- Low bit cost;

IV. LTE SCHEDULER

The Long Term Evolution (LTE) cellular communication system has emerged as a fast-growing prevalent technology, delivering a diversity of mobile broadband services, in the communication market. The LTE specifications have been standardized to utilize Orthogonal Frequency Division Multiple Access (OFDMA) as the transmission scheme, commissioned to carry out the downlink communication. The OFDMA transmission scheme in comparing with the old one (Code Division Multiple Access) provides a key advantage of flexibility for resource allocation decision makers in exploiting frequency diversity. An LTE scheduler is expected to allocate radio resources efficiently to support a high variety of services and maximize system throughput. However, it is a crucial problem to accomplish all targets at the same time. Each factor can be supplied at the cost of reducing another one.

V. QOS IN LTE

A flexible QoS-oriented scheduler, divided into Time Domain (TD) and Frequency Domain (FD), was introduced in for real-time video traffic. The proposed algorithm considers arrival rate and head of line packet delay as influential QoS factors for multiuser resource distribution. To simplify the complexity of the resource allocation procedure, it has been partitioned into three separate stages: QoS classes identified classification, time domain and frequency domain scheduling. At the first step each bearer is classified into individual QoS class based on its CQI factors. Then the TD scheduler prioritizes the classified bearers according to their QoS data rate requirements and categorizes them into separate prioritized candidate bearers: GBR and Non-GBR. GBR bearers typically carry real-time applications which are sensitive to delay and need to be served with a guaranteed bit rate. OSA algorithm sorts each GBR bearer according to the Head of Line (HOL) packet delay in the buffer of the related bearer.

The ranking function of traditional scheduling algorithms which are only based on the queue’s priority, ignoring other metrics, would impose a lack of sufficient intellect over the resource allocation process. In response to this challenging problem, LTE introduced Knapsack scheduling algorithm with emphasis on overload states. This class-based resource allocation algorithm supports QoS constraints by ordering the bearers using a ranking function calculated based on the multiple metrics, including GBR/Non-GBR class priority, bearer queue status, packet loss and delay. However, since the main volume of the LTE network traffic is real-time services, growing in an explosive manner, especially video and VoIP, the fairness issue among these services forms a major challenge as well as QoS support in current networks.

VI. RELATED STUDY

Nasim Ferdosian et al. [1] addressed this fundamental problem of LTE downlink scheduling by adopting the time-domain Knapsack algorithm over the traffic overload patterns and fine tune the Knapsack algorithm, to overcome this problem and improve system performance objectives. In LTE systems, multicast services must be delivered efficiently in response to the need for strong QoS support. However, each class of quality services has its own requirements to be satisfied. These quality constraints limit the scheduling flexibility, and the LTE downlink resource allocating algorithms need to assimilate these constraints while trying to maximize system performance in terms of fairness and throughput.

Vikas Kaul et al. [2] presented design, implementation, evaluation and comparison of security enhancements in data transmission for next generation encryption highlighting the possible weaknesses within the current AES encryption algorithm. An enhanced encryption method with AES algorithm is used here within TLS. Enhancement is done in AES by first using chaos and then modifying the S-box .The use of chaos sequence makes the key space infinite and the static S-box is made dynamic using cipher key. To increase the complexity of the system, AES is integrated in Round structure. The evaluation focuses on: Encryption- Decryption time, Throughput-speed and Avalanche effect.

Tarik Ghalut et al. [3] focused on the development of Quality of Experience (QoE) aware optimization downlink scheduling video traffic flow. QoE is the overall acceptability of a service or application, as perceived subjectively by end users and then introduced a novel integration framework between genetic algorithm (GA) and random neural networks (RNN) applied to QoE-aware optimization of video stream downlink scheduling. The proposed framework has been applied and evaluated using an open source simulation tool for LTE networks (LTE-Sim). A comparison between our framework and state-of-the-art LTE downlink scheduling algorithms (FLS, EXP-rule, and LOG-rule) has been done under different network conditions.

Nora A. Ali et al. [4] introduced general expressions for the SINR in homogeneous and in heterogeneous networks. In homogeneous networks, the expression was applied for the most common types of frequency reuse techniques: soft frequency reuse (SFR) and fractional frequency reuse (FFR). The expression was examined by comparing it with previously developed ones in the literature and the comparison showed that the expression is valid for any type of frequency reuse scheme and any network topology. Furthermore, the expression was extended to include the heterogeneous network; the expression includes the problem of co-tier and cross-tier interference in heterogeneous networks (HetNet) and it was examined by the same method of the homogeneous one.

Ajay Kaushik et al. [5] analyzed physical layer of LTE transceiver for downlink channel in FDD (frequency division duplexing) mode. Simulation results analyses the throughput performance of LTE PDSCH channel for ETU (extended typical urban) model in terms of SNR and for no. of frames transmitted.

Neelam Rani and Sanjeev Kumar [6] classified the existing ICIC techniques and investigates the performance of reuse-1, reuse-3 schemes under various user distributions. Performance of cell-center and cell-edge users is inspected, as well as the overall spectral efficiency, throughput and network load. System level simulations are performed that shows the advantages and limitations of each of the examined techniques under different network loads and user distributions which is used to determine the most suitable ICIC technique to be used. However, the simultaneous usage of the same Frequency in adjacent LTE cells that creates inter-cell interference problems at cell-edge users. Inter-Cell Interference Coordination (ICIC) techniques are deployed to avoid the negative impact of interference on system performance.

Varun Das and Shikha singh [7] reviewed that Long-Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals. It is based on the GSM/EDGE & UMTS network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. The main difference between LTE & UMTS is that the LTE is purely packet switched network. During congestion loss of packets occurs which affects the performance of LTE.

Prinima and Jyoti Pruthi [8] aimed to address the evolution of mobile communications, from its first generation, 1G, to the latest 5G. This drives the main intention of the cell phone giants to search for the new technology to outperform their competitors. The users can use these applications at anytime and anywhere through mobile communication.

Senthilkumar Mathi and Lavanya Dharuman [9] deliberated the vulnerability of desynchronization attack that occurs when source acts as rogue base station in 3GPP. In addition, it discusses how this attack jeopardizes the communication in 4G network and subsequently proposes a new scheme to overcome this attack. In the proposed scheme, the target generates its own key rather than using the key generated by source node for future communication with target to achieve a secure communication between the source and target base station in 4G LTE.

Vasco Pereira and Tiago Sousa [10] addressed the evolution of mobile communications, from its first generation, 1G, to the latest 3G and give a glimpse of foreseeable future of 4G. Mobile communications play a central role in the voice/data network arena. With the deployment of mass scale 3G just around the corner, new directions are already being researched.

VII. PROBLEM FORMULATION

This current work had focused on downlink resource scheduling with QoS and fairness constraints for different quality classes in LTE networks. This technique describes the resource allocation as a multi-objective optimization problem, covering three main performance targets of LTE scheduling. The desired solution which is selecting and scheduling the best candidate bearers was provided by using a throughput aware knapsack algorithm to maximize the desired performance targets. With respect to average throughput measurements we can conclude that by modifying the Knapsack algorithm to use a throughput aware ranking function the system performance in terms of total throughput can be enhanced in several classes of QCI to the close levels.

A mobile network consists of one or more autonomous mobile nodes, each of which communicates directly or indirectly with the neighbor nodes within its radio range. The field of Mobile Network is rapidly growing due to varied advantage and applications. Energy efficiency is a challenge faced especially in designing a routing protocol. A single routing protocol is hard to satisfy all requirements. i.e., one routing protocol cannot be a solution for all energy efficient protocol that is designed to provide the maximum possible requirements, according to certain required scenarios.

1. There is not any alternative path for downlinks.
2. Data packets are dropped due to downlinks.
3. Decrease in throughput.
4. In case of link failure repeat rescan of network decreases the efficiency and reduce power of battery.
5. No improvement for increased delay.
6. Maximize the increased network lifetime.
7. In-secure transmission in routing protocols.

VIII. FLOWCHART

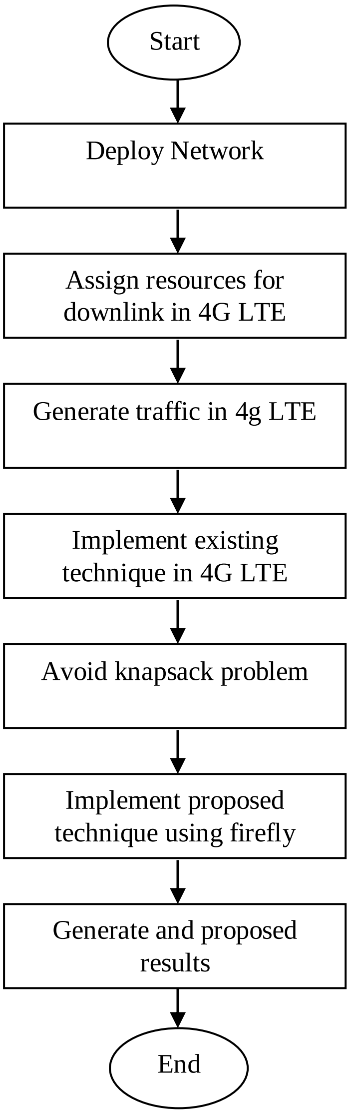

Fig 1: Flow chart

IX. AACO

Adaptive Ant Colony Optimization (AACO) is an adaptive technique to find partial solutions for the problems where identifying exact solution is either difficult or impossible. The problem of optimization is the most crucial problem in today's era and a great work has been done to solve it. During last few years, many optimization algorithms, like Ant Colony Optimization (ACO), Particle Optimization Problem (PSO), Artificial Bee Colony Algorithm (ABC), Differential evolution (De), Genetic algorithm (GA) etc., has been proposed. Ant Colony Optimization (ACO) [1] algorithm was proposed firstly in 1991 by Dorigo M. and was designed to simulate the foraging behavior of real ant colonies. ACO algorithms have been widely used for solving different combinational optimization problems such as Job-Scheduling Problem, Traveling Salesman Problem, and Vehicle Routing Problem etc. Various enhanced versions of the original ACO algorithms have been done over the years. For improving the quality of final solution and speedup of the algorithm, various strategies like dynamic control of solution construction, mergence of local search, partition of artificial ants into two groups: common ants and scout ants, strategies for updating new pheromone and using strategies of candidate lists are studied. ACO model may be better in the search result of the shortest route but some scenarios may have the other factors using the route selection such as favor, convenience, traffic on route, etc., in which AACO model can provide better support such other factors

X. RESULTS AND DISCUSSION

In this scenario a comparison is made between hybrid routing schemes by taking 25 subscriber stations which is shown below.

- **Load:** Load may be defined as the total number of packets in a network at a time t.

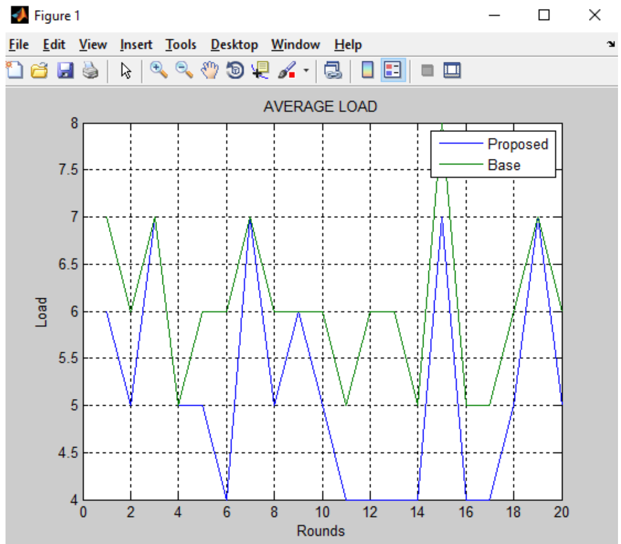

Figure 2: Average load

Load: The load in two MANET protocols called existing and proposed in 25 nodes. From the above graph it is shown that the load in proposed approach is less than that of existing approach. From the figure 2 it is cleared that the average load in the proposed technique is approx 5 Kb/s where as in case of existing scheme it is approx 6.5 Kbps.

Delay: Network delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. Although users only care about the total delay of a network, engineers need to perform precise measurements.

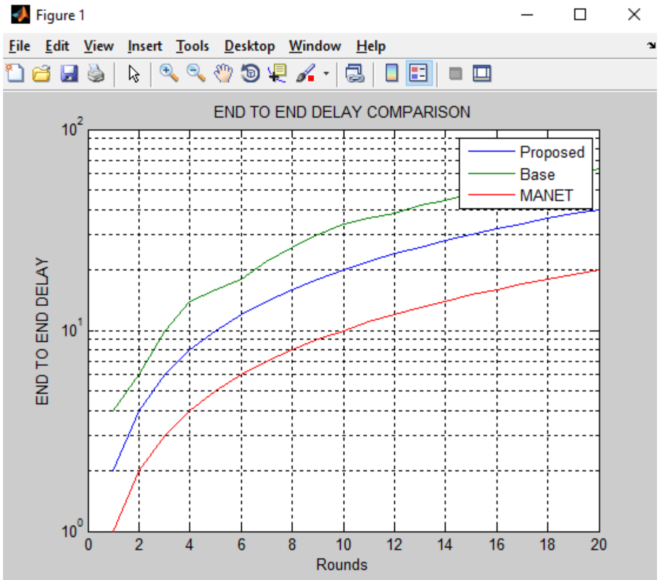

Figure 3: Delay

Delay: Delay in existing and proposed approach in MANET in 25 nodes. From the graph it can easily depicted that the delay in enhanced PROPOSED is less than that of existing PROPOSED protocol. As depicted from the figure 5.2 it may be defined that the delay in the existing approach is approx 80ms where as in case of proposed approach it is 65ms.

Throughput: Throughput is the maximum rate of production or the maximum rate at which something can be processed. When used in the context of communication networks, such as Ethernet or packet radio, 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. Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second (p/s or pps) or data packets per time slot.

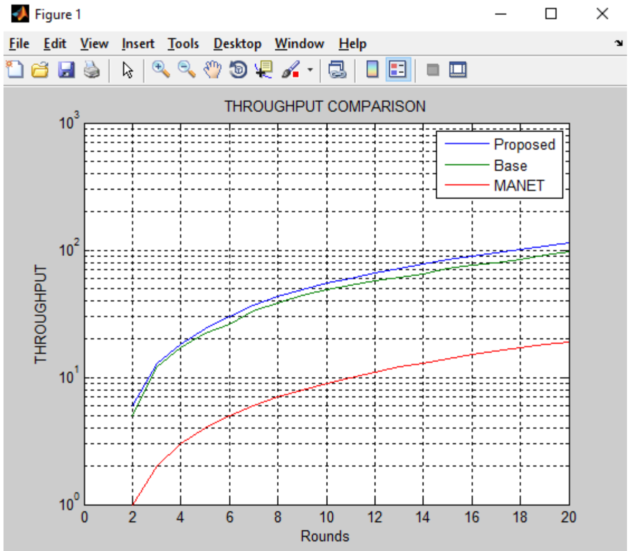

Figure 4: Throughput

Throughput: Throughput in enhanced PROPOSED and PROPOSED in MANET in 25 nodes. From the graph it can easily depicted that the throughput in enhanced PROPOSED is less than that of existing PROPOSED protocol. Throughput in case of proposed case is approx 110 packets and in existing case it is approx 100 packets.

Jitter: Jitter is simply the difference in packet delay. In other words, jitter is measuring time difference in packet inter-arrival time. It is a specific phenomenon that normally exists in bigger packet switched networks. As a time shift phenomenon it usually does not cause any communication problems. Actually, TCP/IP is responsible for dealing with the jitter impact on communication.

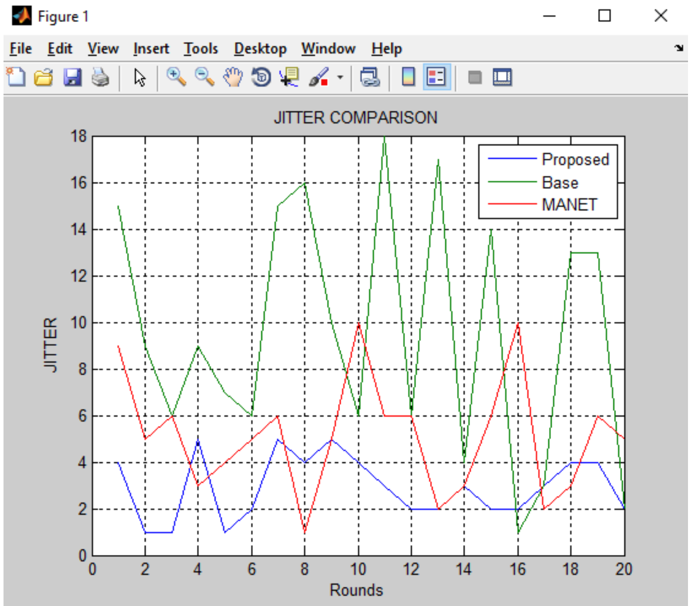

Figure 5: Jitter

Jitter: Jitter in enhanced PROPOSED and PROPOSED in MANET in 25 nodes. From the graph it can easily depicted that the jitter in enhanced PROPOSED is less than that of existing PROPOSED protocol. Jitter in case of proposed case is approx 3.5 sec and in existing case it is approx 7 sec.

Power Left: Energy left or power left may be defined as the energy or power residual at a time t in network nodes. Energy is consumed in the network by the packet transmission, packet reception, amplification and by fading. So energy left or power left may be defined as the total power – power consumed.

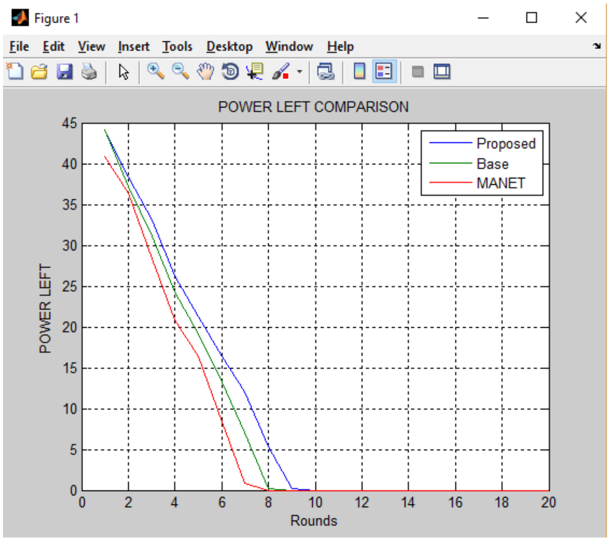

Figure 6: Power Left

Power Left: Power Residuual in enhanced PROPOSED and PROPOSED in MANET in 25 nodes. From the graph it can easily depicted that the residual power in enhanced PROPOSED is more than that of existing PROPOSED protocol. Residual power in case of proposed case is retained upto approx 10 rounds and in existing case it is approx 8 rounds.

Power Consumption: Power Consumption may be defined as the energy released by a node during various network operations. Energy is consumed in the network by the packet transmission, packet reception, amplification and by fading.

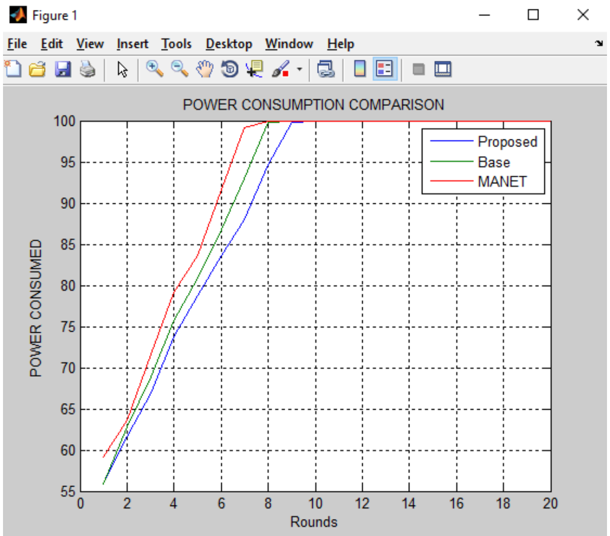

Figure 7: Power Consumption

Power Consumption: Power Consumption in enhanced PROPOSED and PROPOSED in MANET in 25 nodes. From the graph it can easily depicted that the residual power in enhanced PROPOSED is more than that of existing PROPOSED protocol. Residual power in case of proposed case is retained upto approx 10 rounds and in existing case it is approx 8 rounds

XI. CONCLUSION

MANETs are the adhoc network that don't have any fixed topology and can easily send data from source to destination in wireless mode through some routing protocol. In the current research the enhancement of the secured MANET routing protocol is done. The protocol chosen for enhancement is optimization based routing protocol due to the low QOS in the existing algorithm. Encryption is quite an important parameter in the MANET. To make PROPOSED more secure 3d cryptography technique is implemented in it for secure transmission. By applying the encryrption technique in the PROPOSED, some times the overheads are introduced in it. To overcome the problem of data dropped, load and encryption overheads in the network, an optimization technique called Adaptive ACO are used. Using the above mentioned optimization technique the data dropped and the losses in the network are reduced to some extent. The above defined results have shown the parameters that are improved using a network simulator called MATLAB. The PROPOSED generates much load on the network and the packets start delayed in network. This problem is reduced in the proposed approach using an optimization technique which makes multiple paths to the packets that are sent to the destination. By using the exactly reciprocal path the network can send data through multiple paths and the load in the network can be reduced.

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